NovaCLB-Screen Full-screen Calibration System User Manual

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Ver：3.3.1

Content

1 Introduction

1.1 Why Pixel Level Calibration

Brightness / Color uniformity is of the most important factors that affect the image quality of a full color LED display. Because of the limitations of the manufacturing process, including system structure design, LED lights selection, electronic components welting, system cooling, LED brightness decaying and many others, LED displays suffer the brightness / color uniformity loss, which is also the most serious problem of this field.

Facing this fact, Nova pixel level calibration system does not intervene the manufacturing processing of a LED display to reduce its brightness / color uniformity. Instead, it performs brightness / color adjustment to the display after it has been completely produced. By adjusting the brightness / color of each LED light according to the software analytical results from the measured brightness / color values of the LED lights, Nova pixel level calibration system can help the LED display acquiring perfect uniformity.

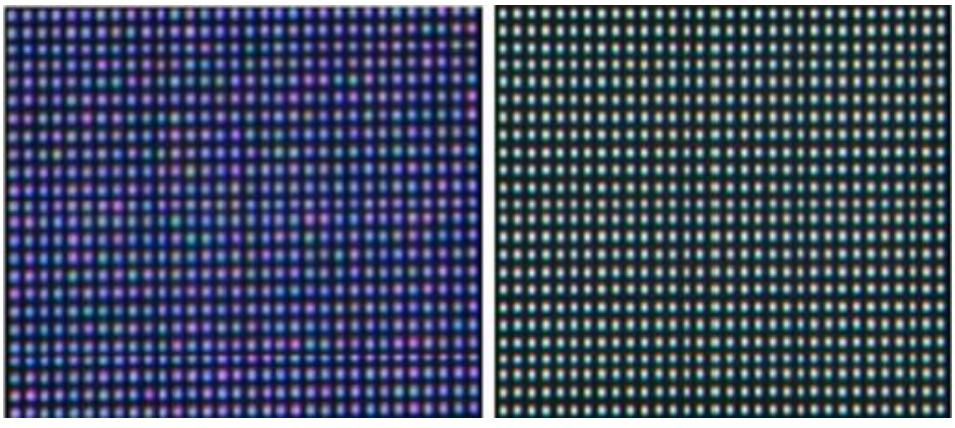


Fig.1-1 The LED display effects comparison before and after calibration

NovaCLB is applicable for the following two occasions:

- Factory single cabinet pixel level calibration (Factory calibration). Correct each cabinet on the production line to ensure good brightness / color uniformity of the cabinets when produced.
- Field LED display pixel level calibration (Full-screen calibration). Perform calibration for a LED display at where it locates to improve its brightness / color uniformity.

Factory calibration is more efficient and lower in cost than Full-screen calibration. But for cabinets of which the LED lights optical axis directions consistency is not well managed, results of factory calibration will not be as good as that of filed calibration. When doing factory calibration, the matching NovaCLB-Cabinet 2012 is needed.

Full-screen calibration requires engineers to be presence and Full-screen installation of calibration instruments. And what' s more, Full-screen calibration can only be performed only at night when it' s dark. Despite its complexity and low efficiency (compared with factory calibration), Full-screen calibration can greatly improve the brightness / color uniformity of a LED display and thus results in amazing image quality of the display. When doing Full-screen calibration, the matching NovaCLB-Screen 2012 is needed.

1.2 Core Advantages of NovaCLB-Screen

- Camera calibration technology enabling accurate brightness / color measurement;
- Precise calibration coefficients up to 16bits resulting in outstanding calibration performance with brightness variation less than ±1% and color variation less than 0.003;
- Be capable of eliminating color diversity of LED lights from different manufacturing batches;
- Be capable of eliminating brightness / color diversity between subareas or cabinets;

- Arc shape and irregular shape LED display calibration supported;
- Oblique cabinet calibration on production lines supported;
- Supporting automatic calibration for the replaced module;
- Perfect compatible with LED control systems;
- Specific calibration algorithm enabling perfect calibration for low gray level range;
- Close loop intelligent calibration resulting in easy and high efficiency calibration. One LED display, one person; 25 minutes,600K pixels;
- Adopt RGB to begin the collection mechanism and collection-processing mechanism at the same time during the calibration process so as to improve the efficiency;
- Support correction to the boundary difference between partitions so as to enable smooth transition between partitions;
- No extra power supply required.

1.3 System structure

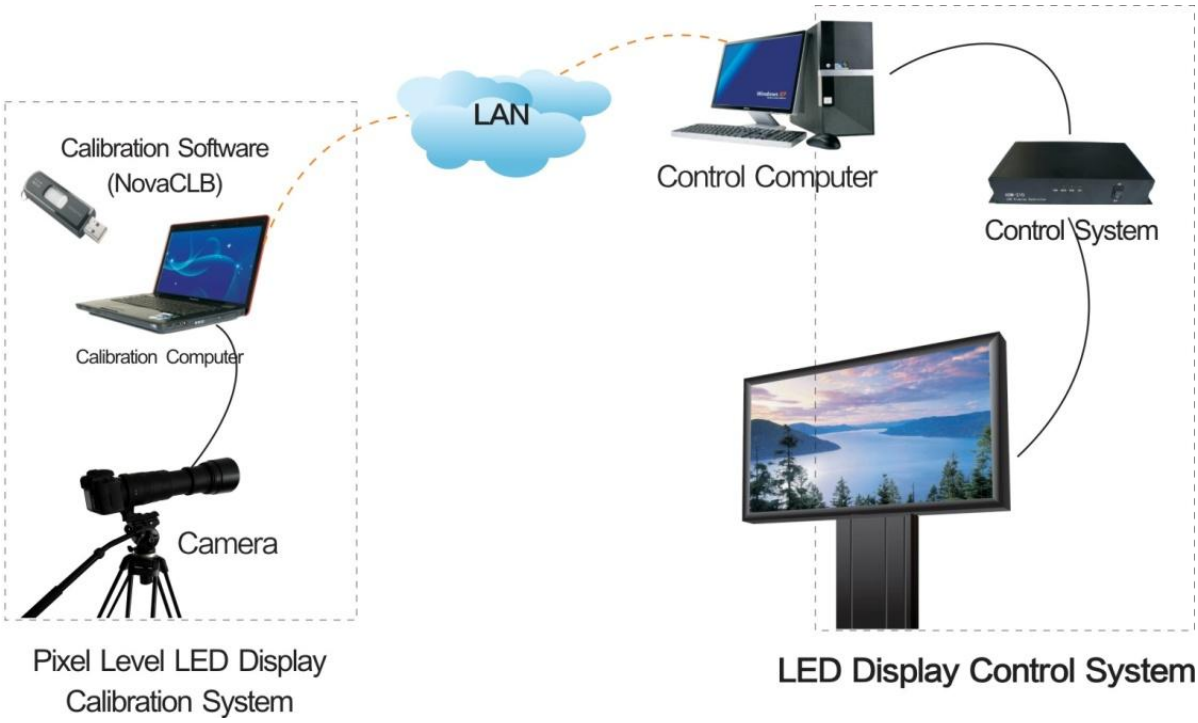
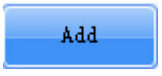


Fig.1-2 System structure

2 Author manage

NovaCLB-Screen adopts the management methods of encryption lock and authorized file binding authorization; and every dongle corresponds to one authorized file, which is combined with the file authorization.

When the software is operated fist, the software is not authorized and it cannot be used normally. You must set the authorization for the software, the operation of the method is as follows.

Insert dongle to the USB port of the computer; click menus "Author"→ "Author manage" on the main interface; enter to the Authorization manage window, click 

to import the authorized file (in the disk, please copy it to your control computer) corresponding to the dongle. Multiple authorized files can be imported, thus, the software (after being copied to other computers) can be used by inserting the dongle.

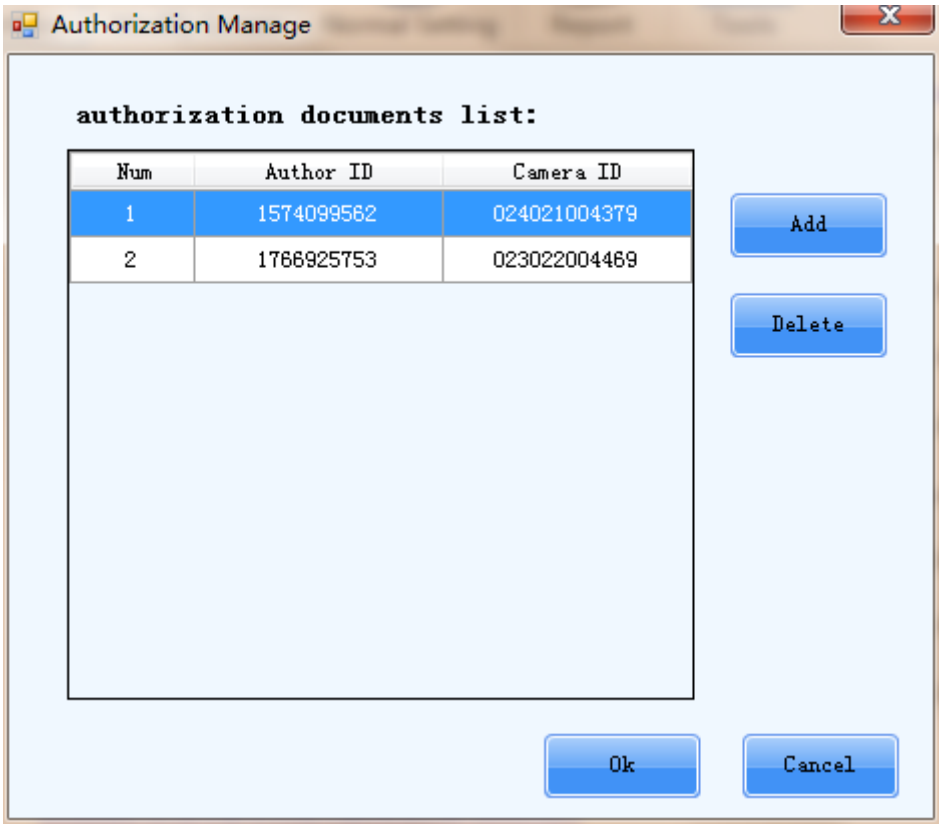


Fig.2-1 Authorization management

3 Full-Screen Calibration

3.1 Operation process

If normal partition mode is selected during partition calibration, the following procedure may be adopted to perform calibration (wherein, " Eliminate the boundaries of the partitions "is optional. In case of partition correction with good results, modify screen may be omitted):

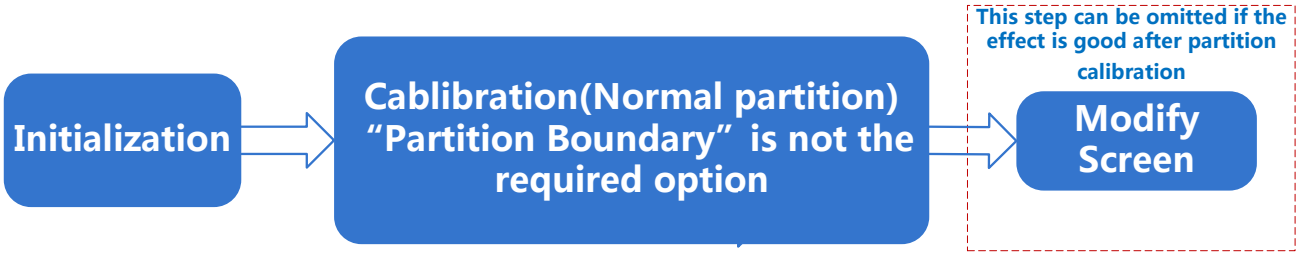


Fig.3-1 Software Operation Process (One)

If large partition mode is selected during partition correction, the following process should be

adopted to perform calibration:

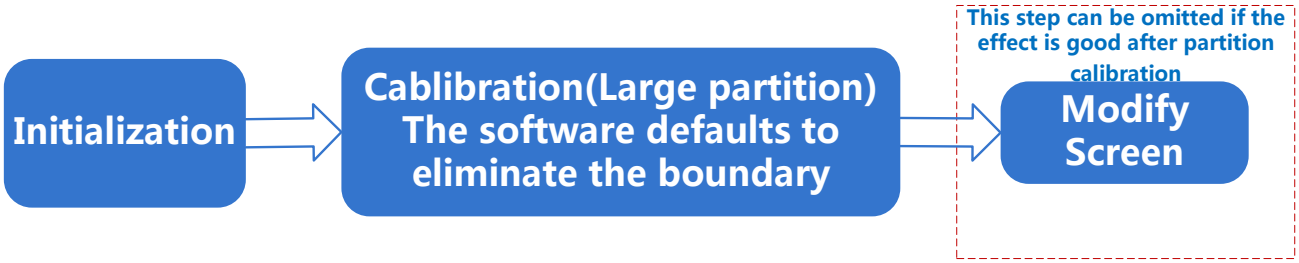


Fig.3-2 Software Operation Process (Two)

- **Initialization**

This interface is designed to initialize a series of calibration parameters, including the communication settings, databases, display information, the original brightness / color parameters and the expected brightness / color, etc.

- **Partitions Calibration**

This interface is committed to guide customers to perform pixel level calibration on each LED light, which signally improve the display uniformity.

Partition Calibration can be divided into normal partition and large partition. Calibrated area of the large partition is several times of the normal partition, thus the large partition is applicable for calibration of large display screen.

- **Partition Boundary**

Eliminate the differences among partitions.

- **Modify screen**

When the partition calibrations totally completed, then it comes to the modify screen. modify screen perfectly eliminate the differences among the partitions, which can make the screen be a flawless whole.

3.2 Calibration Initialization

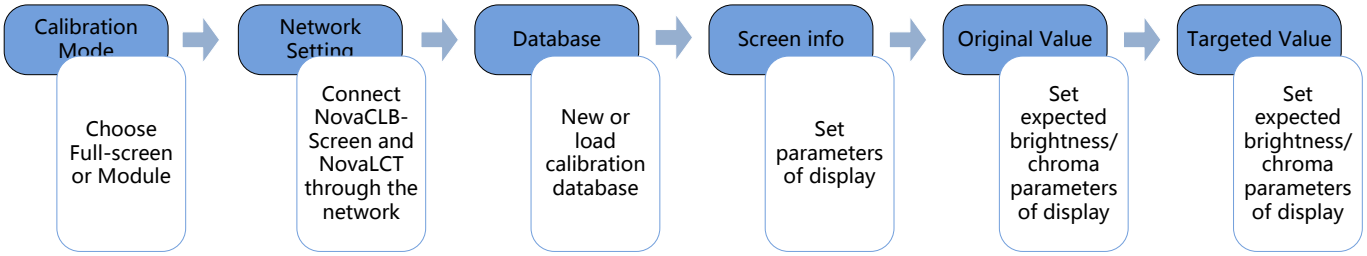


Fig.3-3 Flow chart of Calibration Initialization

3.2.1 Calibration Mode

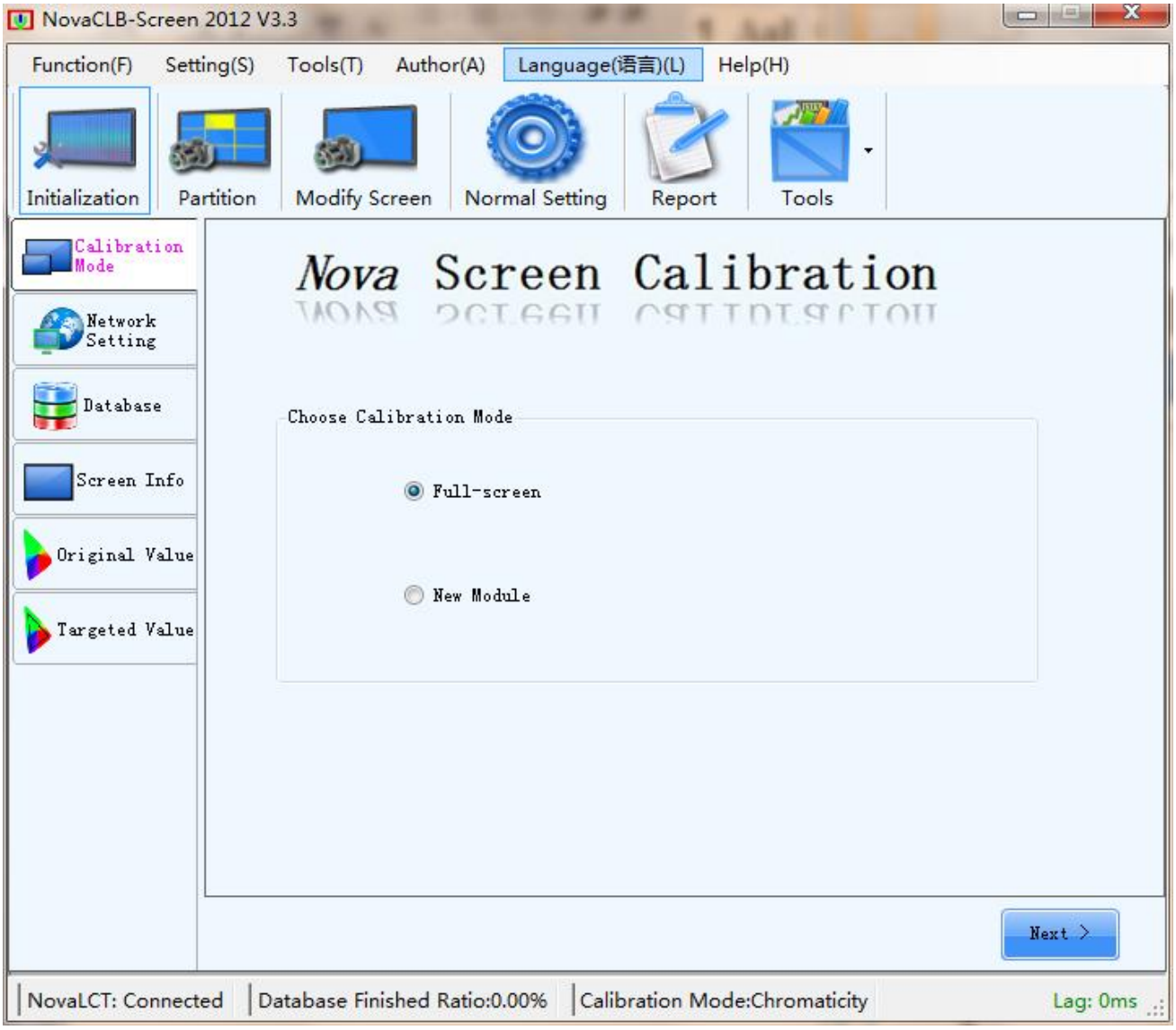


Fig.3-4 Choose calibration mode

3.2.2 Network Settings

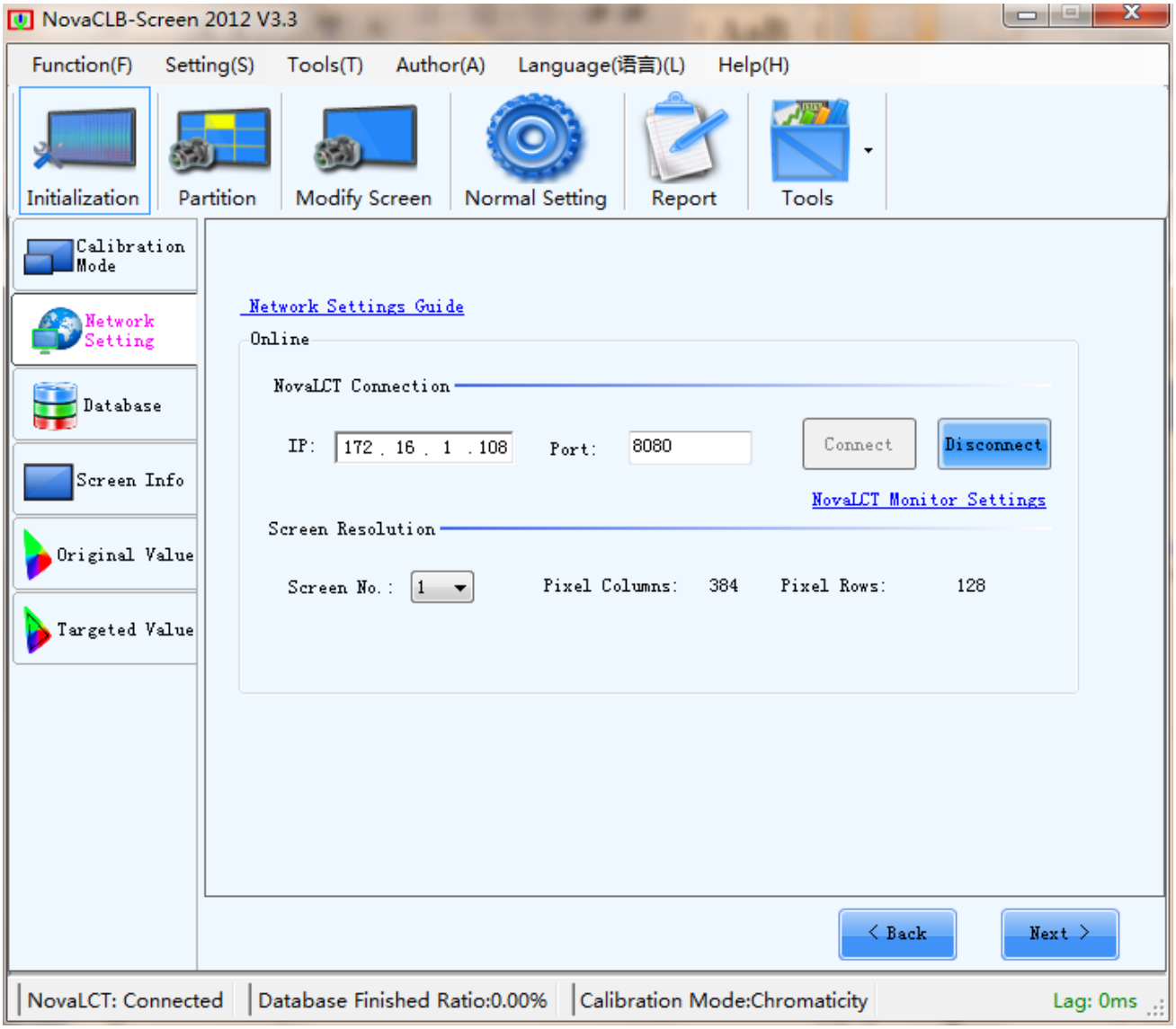


Fig.3-5 Network Settings Interface of Calibration Initialization

✧ Nova LCT Connection

NovaCLB-Screen must be used cooperate with NovaLCT to calibration the display.

Ensure that the NovaCLB-Screen computer can communicate with the NovaLCT computer well, fill the IP and port from NovaLCT in the location of IP and port from NovaCLB-Screen, then click "Connect" button. Fig.3-6 will show up, and the Connection is done.

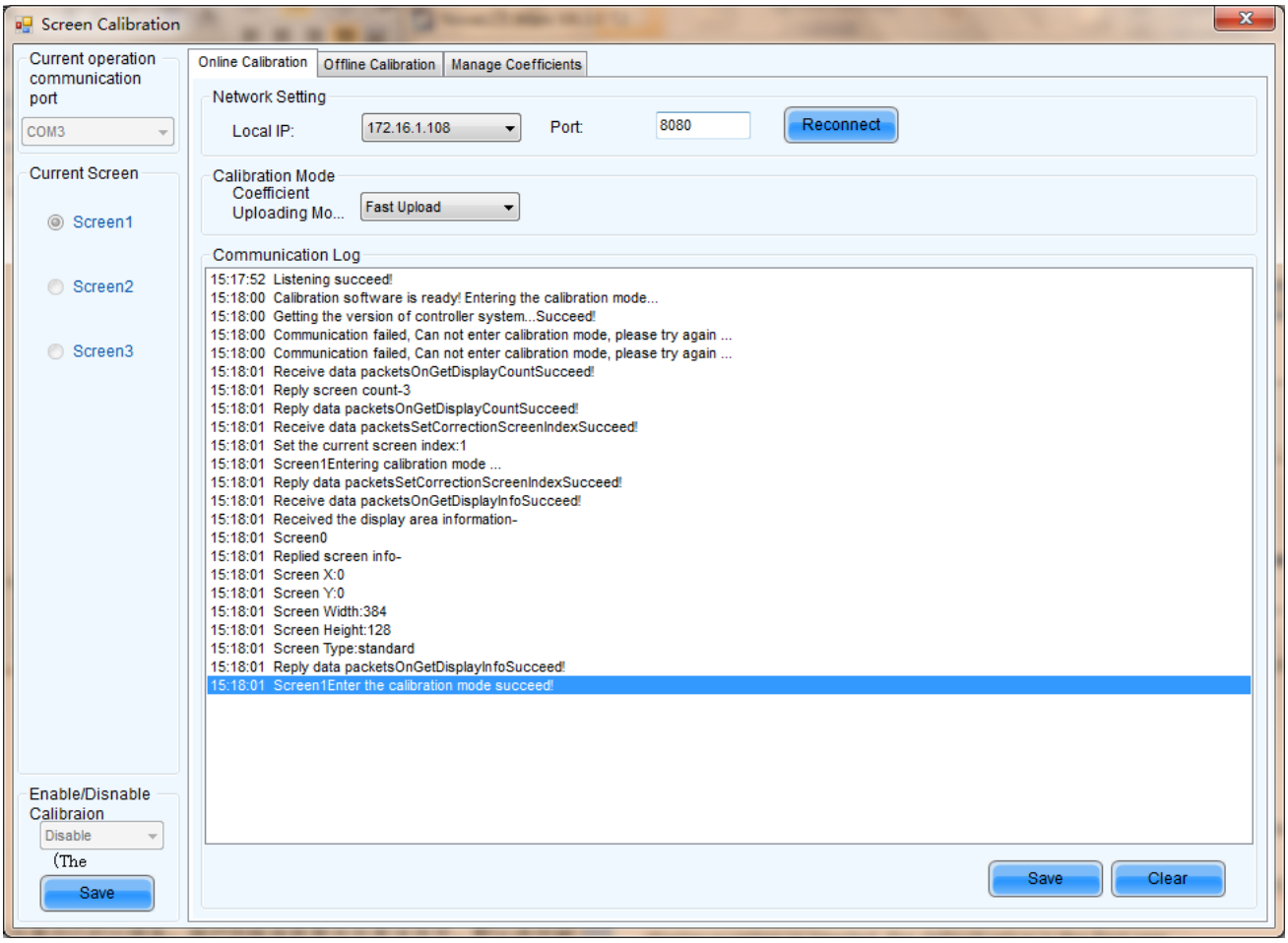


Fig.3-6 Prompt message from NovaLCT when connection is successful

If connection is failed, users could click "guide of network connection" showed in fig.3-5.

✧ Screen Resolution

The resolution of display is the width and height in the pixel level.

After NovaCLB-Screen is connected with NovaLCT successfully, the bottom of interface will show display count and the corresponding resolution of connected NovaLCT. Users could choose display number as needed, the default value is the first one.

3.2.3 Database

A new database or the existing database can be used; and the database is used for saving information of calibration coefficient, calibration time, screen size, etc. it shall be kept properly.

"Backup Database" defaults to be checked, and enabling backup data can effectively prevent

database file damage due to abnormal close of software or sudden blackout of computer.

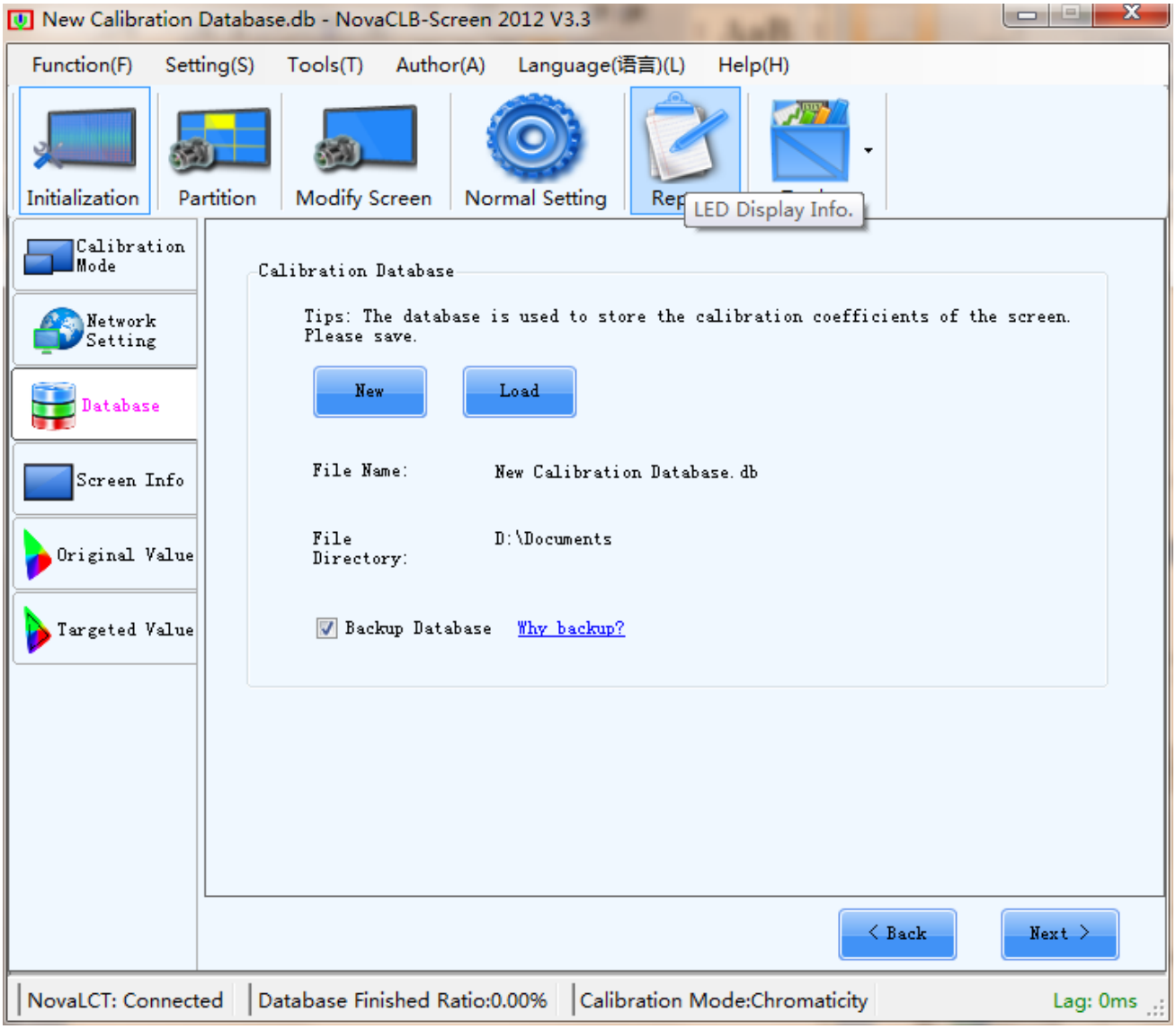


Fig.3-7 Database Interface of Calibration Initialization

✧ Calibration Database

Calibration database is used to store the display’ s calibration coefficient, calibration time, size of display, etc. Please safely keep.

3.2.4 Screen Information

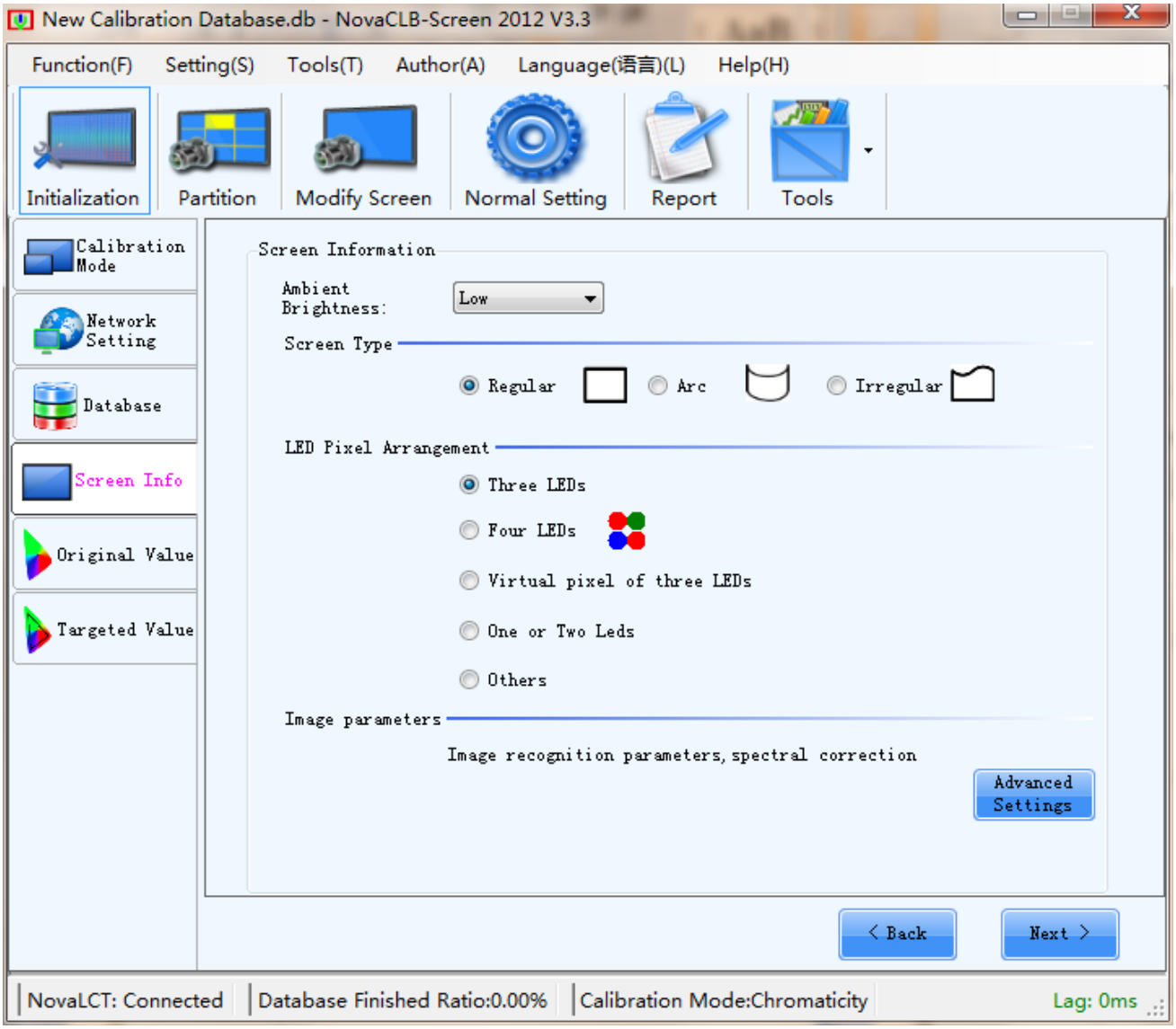


Fig.3-8 Display Information Interface of Calibration Initialization

✧ Ambient Brightness

Ambient Brightness is the brightness of surrounding environment when calibrating. In general, the brightness is "low" at night, it’ s "medium" at nightfall or cloudy day. It is unsuited to calibrate in sunny day.

✧ Screen Type

The type of Screen can be divided as "Regular", "Arc", "Irregular". "Regular" means it is a common rectangular lane display. "Arc" means a rectangular arc display, including inner arc and outer arc. The else are "Irregular".

✧ Pixel Arrangement

Pixel Arrangement is the count of every pixel, the common ones are three LEDs arrangement, Virtual pixel of 3 leds, four LEDs ,Four LEDs, Virtual pixel of three LEDs, One or two leds, and other arrangement, etc.

✧ Advanced settings

The above four terms are the basic parameters information of display. Click "Advanced Settings" button to get in advanced settings interface.

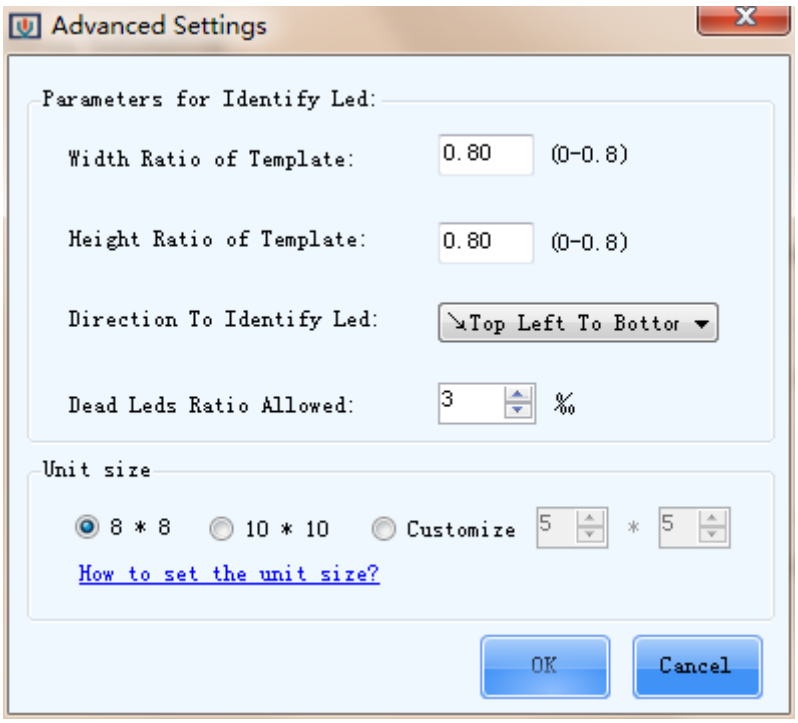


Fig.3-9 Advanced Settings Interface of Display Information

✧ Width and Height Ratio of Template

Identify template for LED, default values are suggested.

✧ Direction To Identify Led

The Direction can be divided into four diagonal directions which are from four angles of rectangle. It is used when identify LED, the default direction is the diagonal from top left to bottom right. When the LED of top left angle can not display normally, please change the direction. For example,

users try to identify LED from bottom right when the first line or the first column is covered.

✧ Dead LEDs Ratio Allowed

If the LEDs which can't be identified in calibrating zone is greater than the ratio, the calibrating flow would stop and some prompt messages will be presented. Please be sure whether the "dead lights are too much" or "some LED pixels are covered" is appeared. If the problem can't be solved, users could turn up this ratio to calibrate forcibly.

✧ Unit size

If pixel columns and rows of a LED display can be divided by 8, then please select 8*8. If pixel columns and rows of a LED display can be divided by 10, then please select 10*10.

3.2.5 Original Brightness and color Measurement

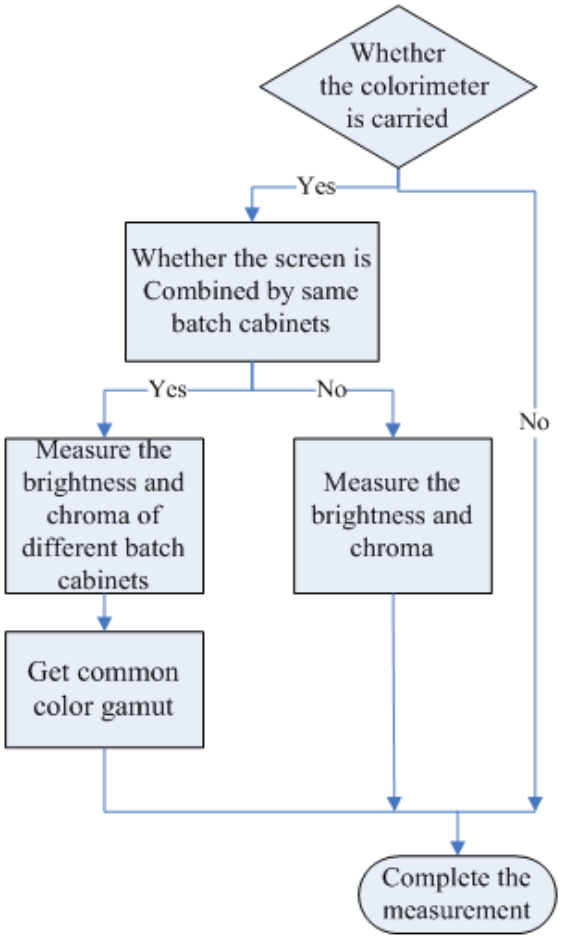


Fig.3-10 Flow chart of Measure Original Brightness and Color

Original brightness and color is the original brightness and color parameters information of the display to be calibrated. It' s important to set these parameters correctly for the result of calibration.

1) Whether the Colorimeter is Carried

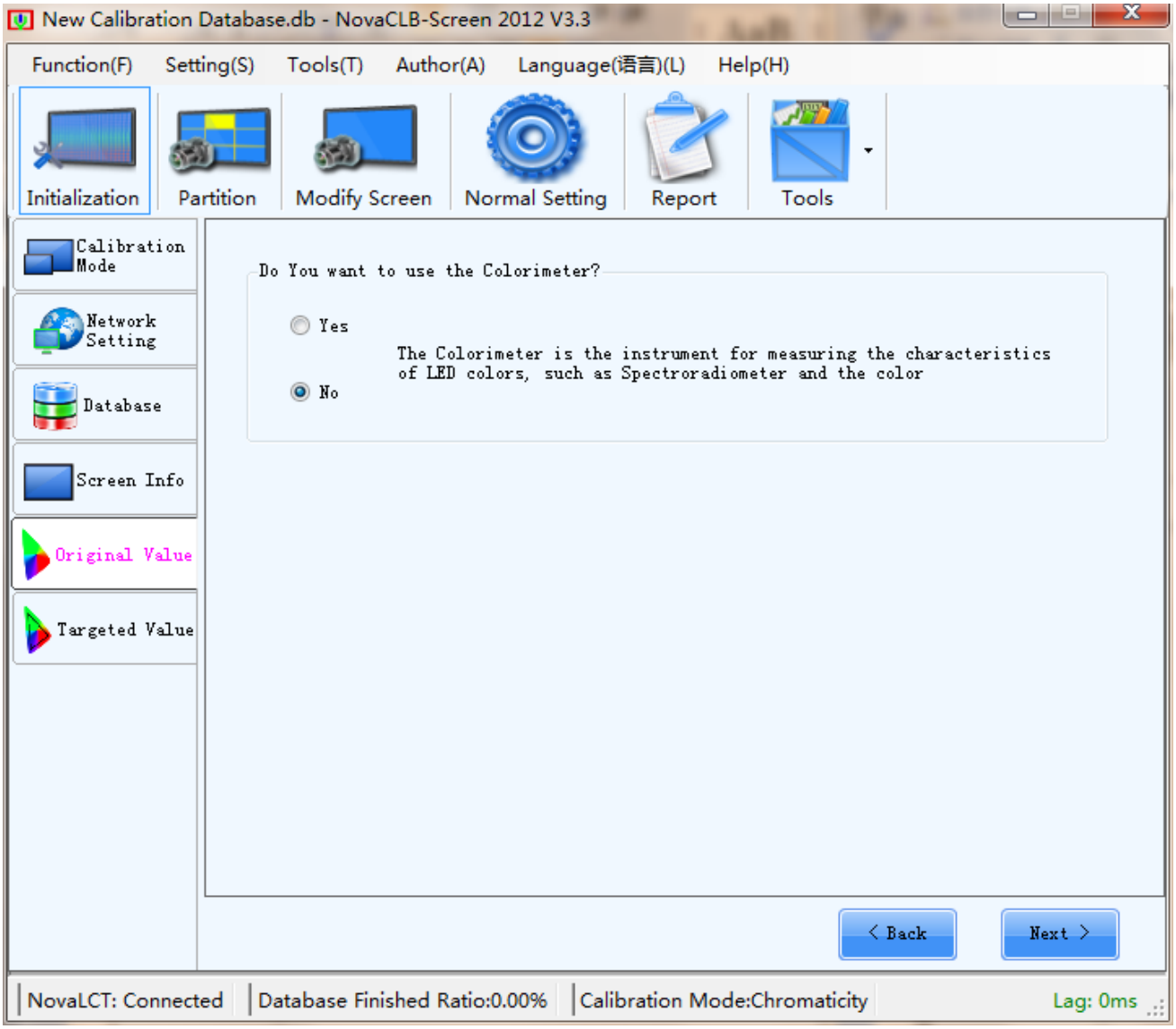


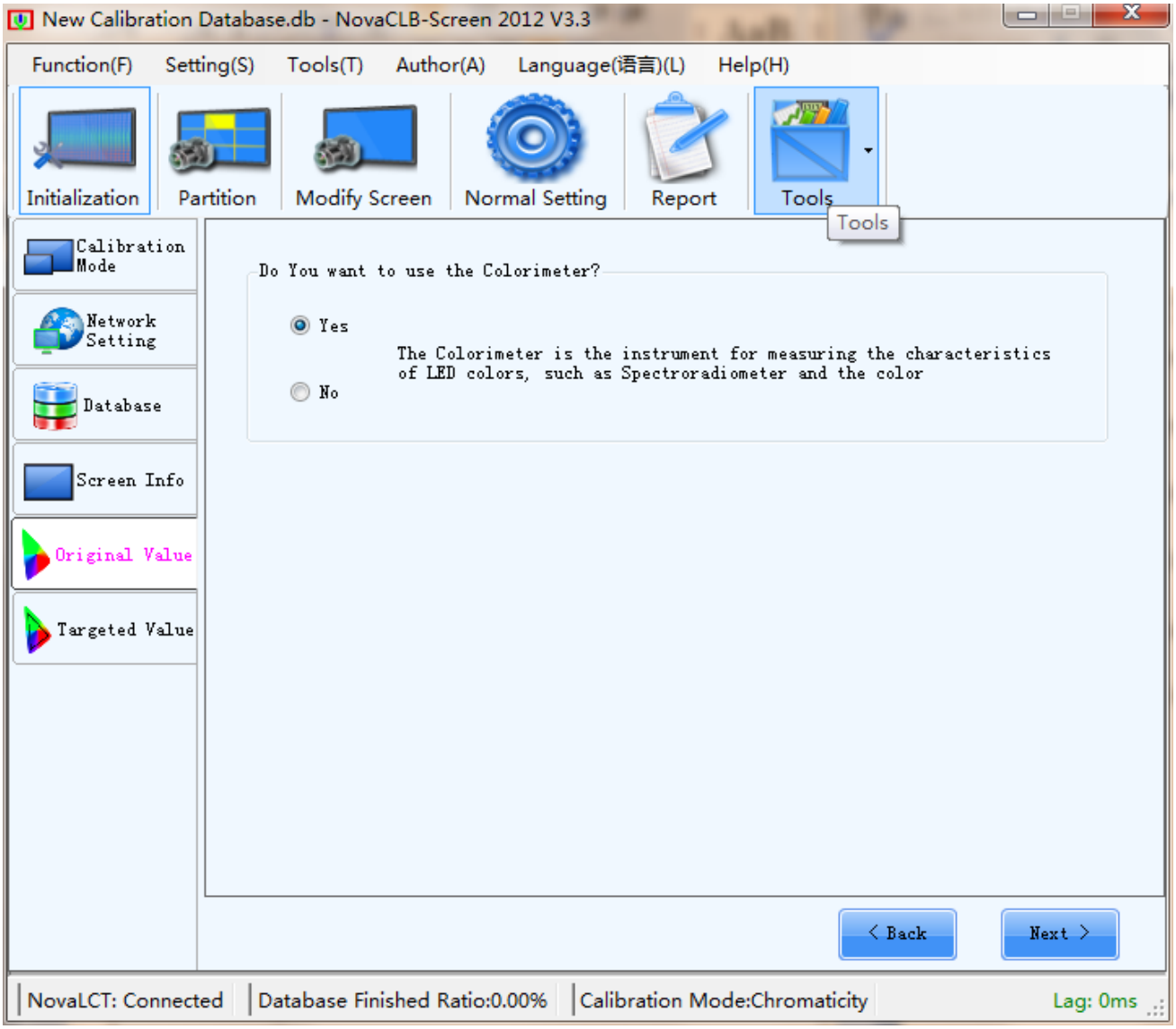
Fig.3-11 Original Brightness and Color Interface of Calibration Initialization

✧ Do You Have The Colorimeter

The colorimeter here means instruments that can measure LED color, like: light gun, color analyzer, Spectral radiation brightness meter, etc. Users can choose as the condition of whether the colorimeter is carried. It’ s recommended to use colorimeter the when calibration.

2) Whether the Screen is Combined by the Same Batch of Cabinets

If the colorimeter is not carried, choose "No", the software would get into "Target Brightness and Color" interface, otherwise, choose "Yes", Click "Next" to get into batches of cabinets for display choosing interface, as shown in Fig 3-12



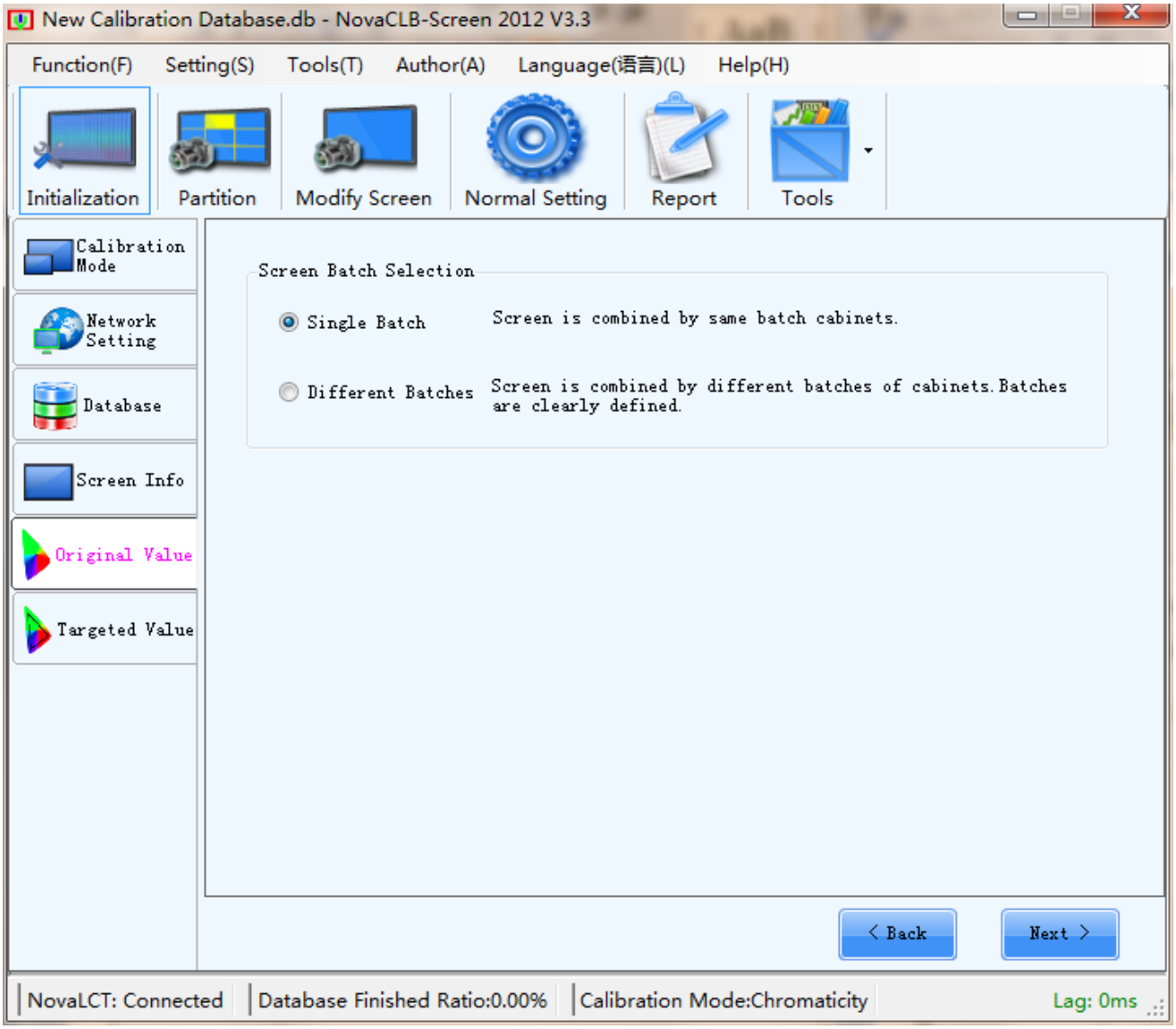


Fig.3-12 Batches of Cabinets for Display Choosing Interface

✧ The Same Batch

The screen is combined by the same batch of cabinets.

✧ Different Batches

The screen is combined by different batches of cabinets. The difference between cabinets is clear.

In this condition, users need to measure brightness and color of different batches of cabinets.

After choosing, Click "Next", get into the detail measurement interface.

3) Screen is Combined by the Same Batch of Cabinets

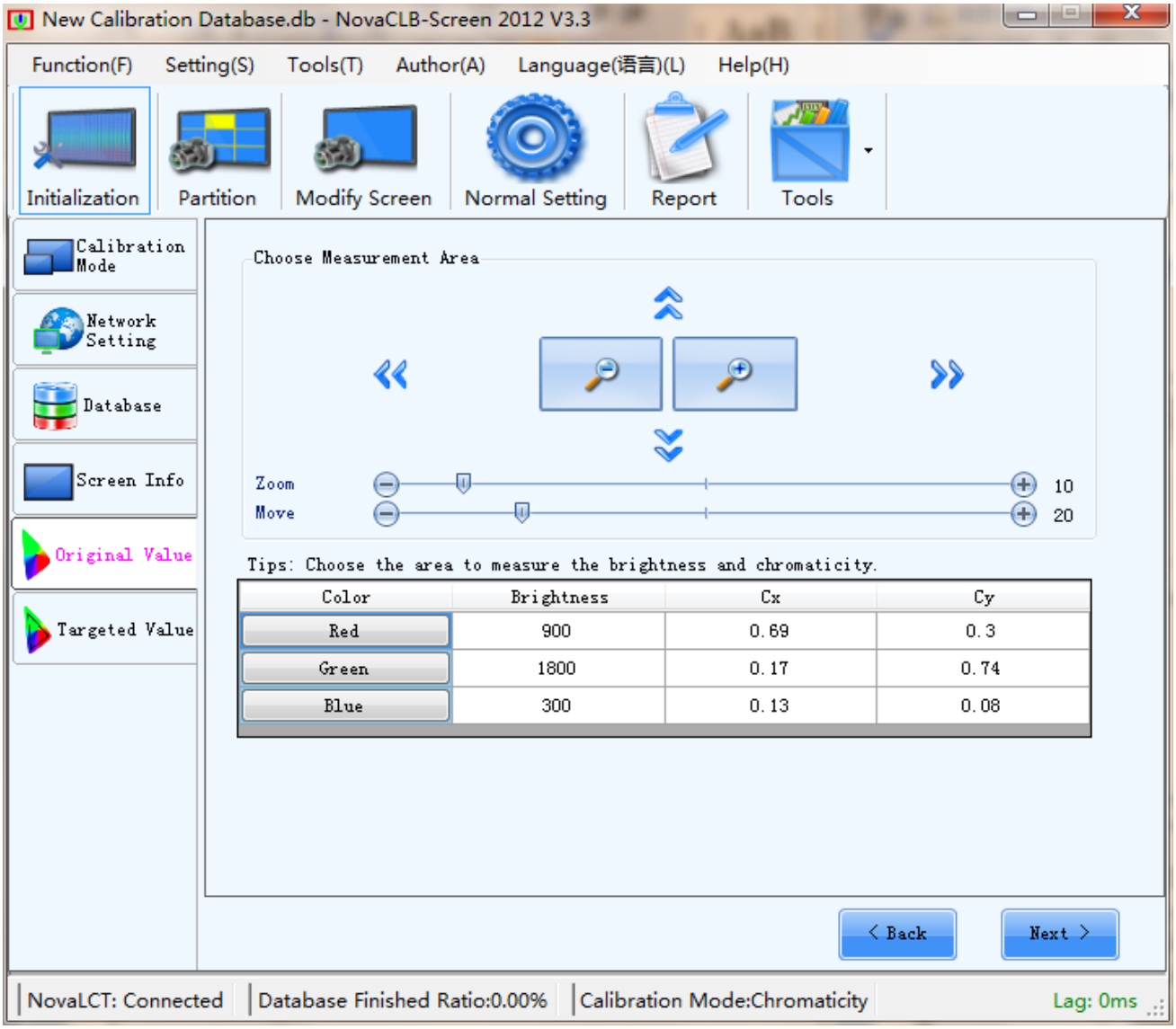


Fig.3-13 Measure Brightness and Color of the Screen Combined by the Same Batch of Cabinets

✧ Measuring Area Choosing

This measuring zone means the alight zone when measuring the brightness and color. It' s aiming at locating measuring zone problem when the screen is combined by different kind of cabinets. Users can change the size and location of measuring zone by click the four direction buttons and the middle button in the interface.

✧ Brightness and Color Information

After Adjusting the measuring zone, users can click "Red", "Green", "Blue" buttons left to the table to control the display color. Then, users can measure brightness, Cx, and Cy to complete

measurement.

4) Screen is Combined by different Batches of Cabinets

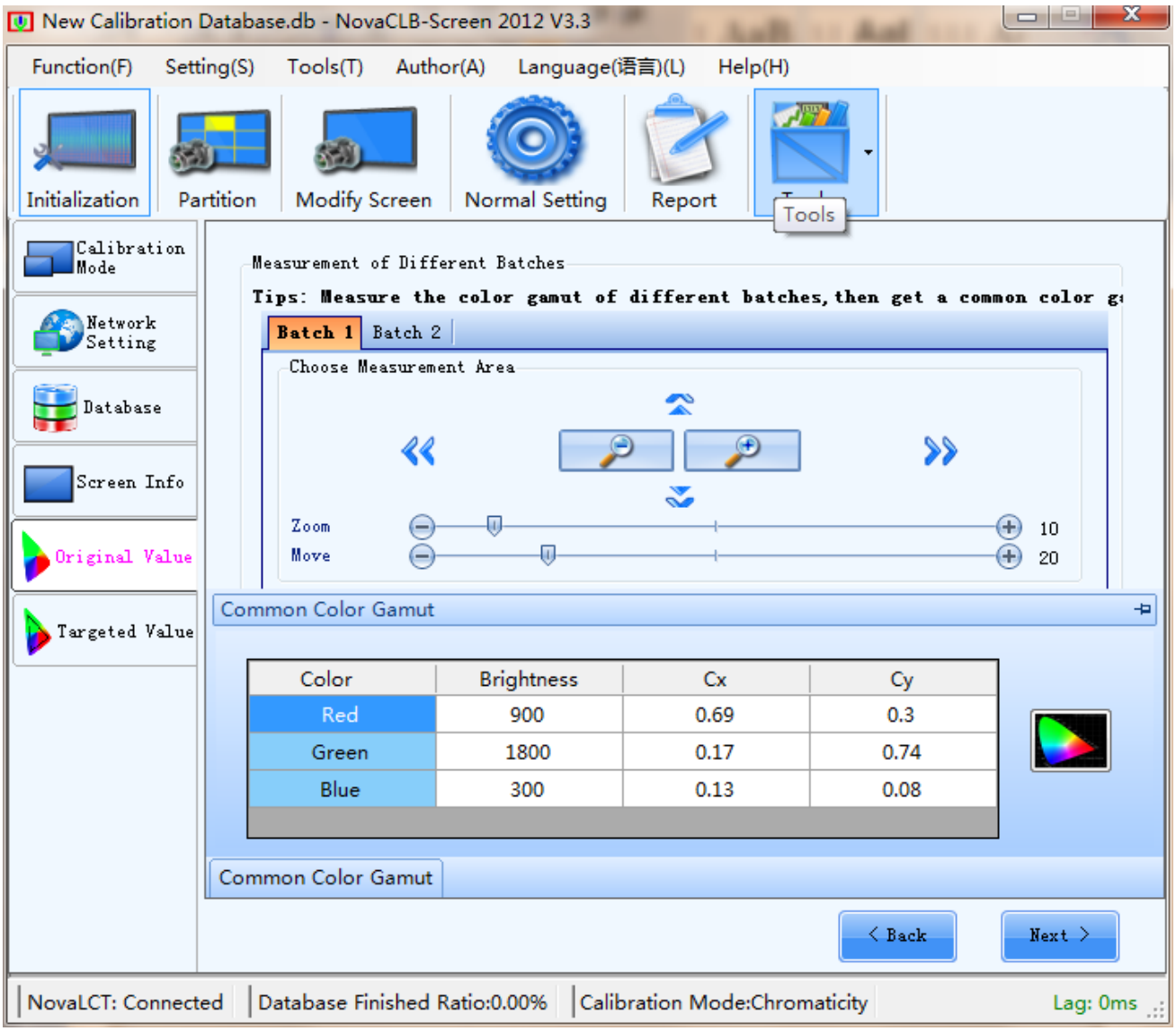


Fig.3-14 Measure Brightness and Color of the Screen Combined by Different Batches of Cabinets

✧ Measuring Zone Adjustment

It's same as the screen combined by the same batch of cabinets.

✧ Batch Adding

In the software, the screen is combined by two batches cabinets by default, users can click "Add Batch" "button to add Batches.

✧ Get Common Color Gamut

"Get Common Color Gamut" is the common part of measuring color gamut of different batches, is the key to achieve consistent uniformity. After complete measuring brightness and color of different batches of cabinets, users should click "Get Common Color Gamut" button.

Thus far, original brightness and color information of display is completed. Click "Next" to get into "Target Brightness and Color" settings.

3.2.6 Target Brightness and Color

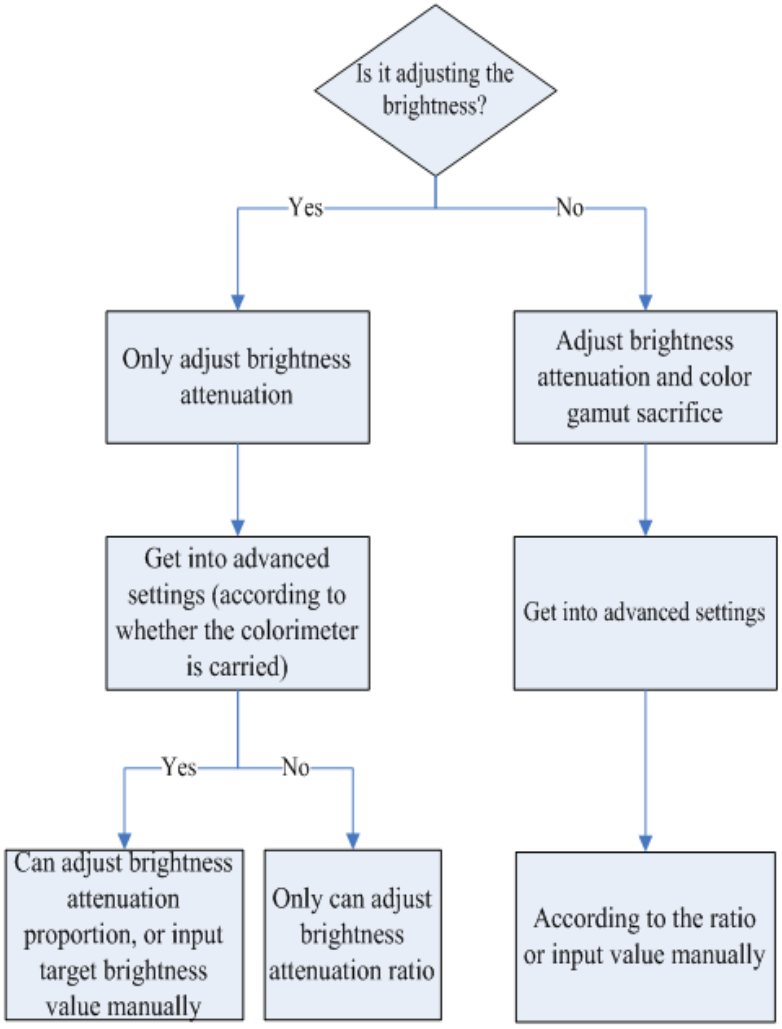


Fig.3-15 Flow chart of Original Brightness and Color Settings

1) Calibration Mode Choosing

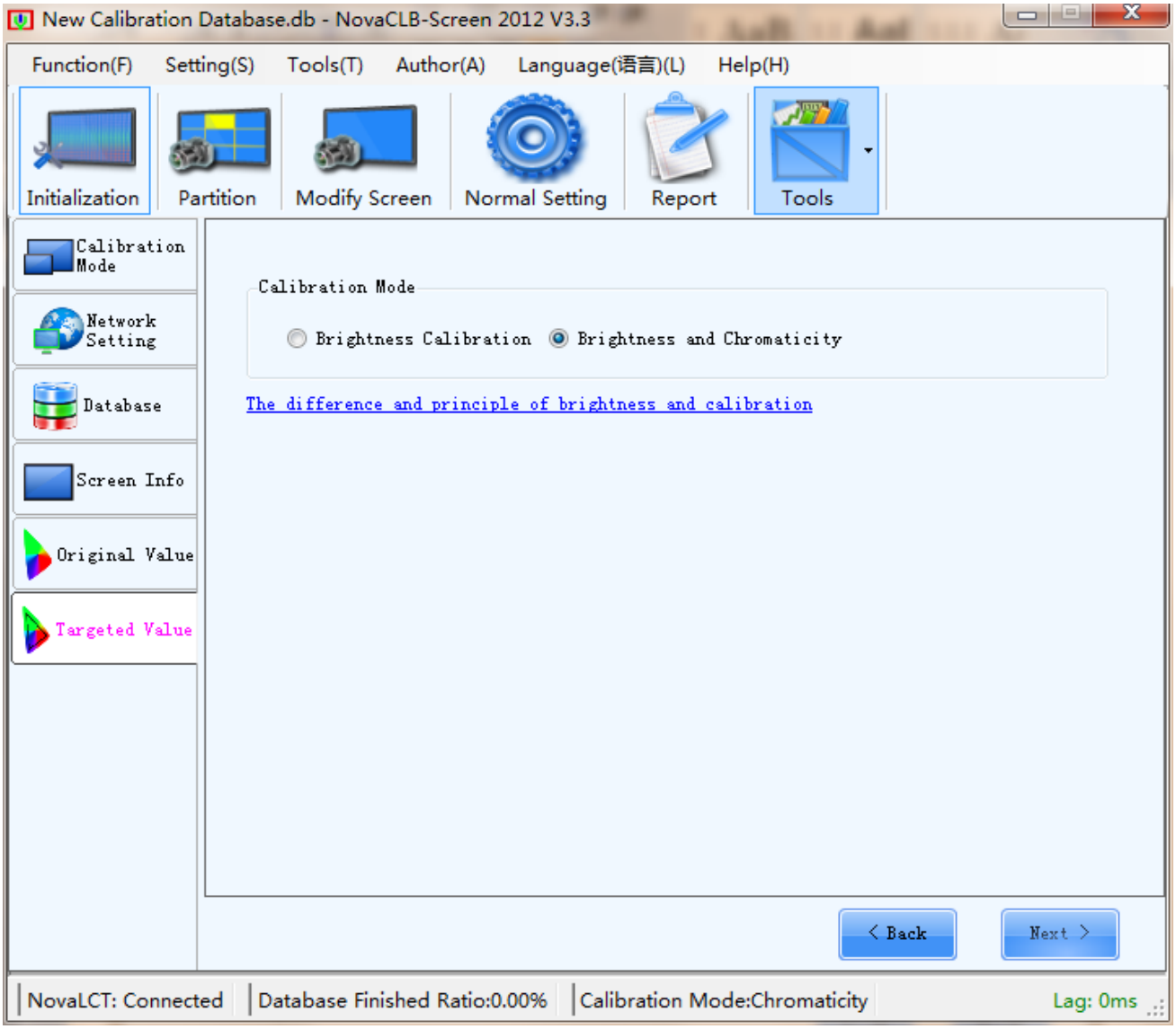


Fig.3-16 Calibration Mode Choosing Interface of Target Brightness and Color Settings

✧ Brightness Calibration

Brightness calibration can only change the brightness of R, G, B, and it will not attenuate the color gamut. But it can't eliminate the difference in color between LEDs.

✧ Brightness and Color Calibration

Brightness and Color calibration can change the brightness of R, G, B, and attenuate the color gamut. But it can uniform brightness and color between LEDs.

Users can click hyperlink "The difference of the Brightness and Color Calibration" in bottom left of interface for detail differences between these two calibrations.

After choosing, click "Next" button.

2) Brightness Calibration

If users choose "brightness calibration", it will show as Fig.3-17.

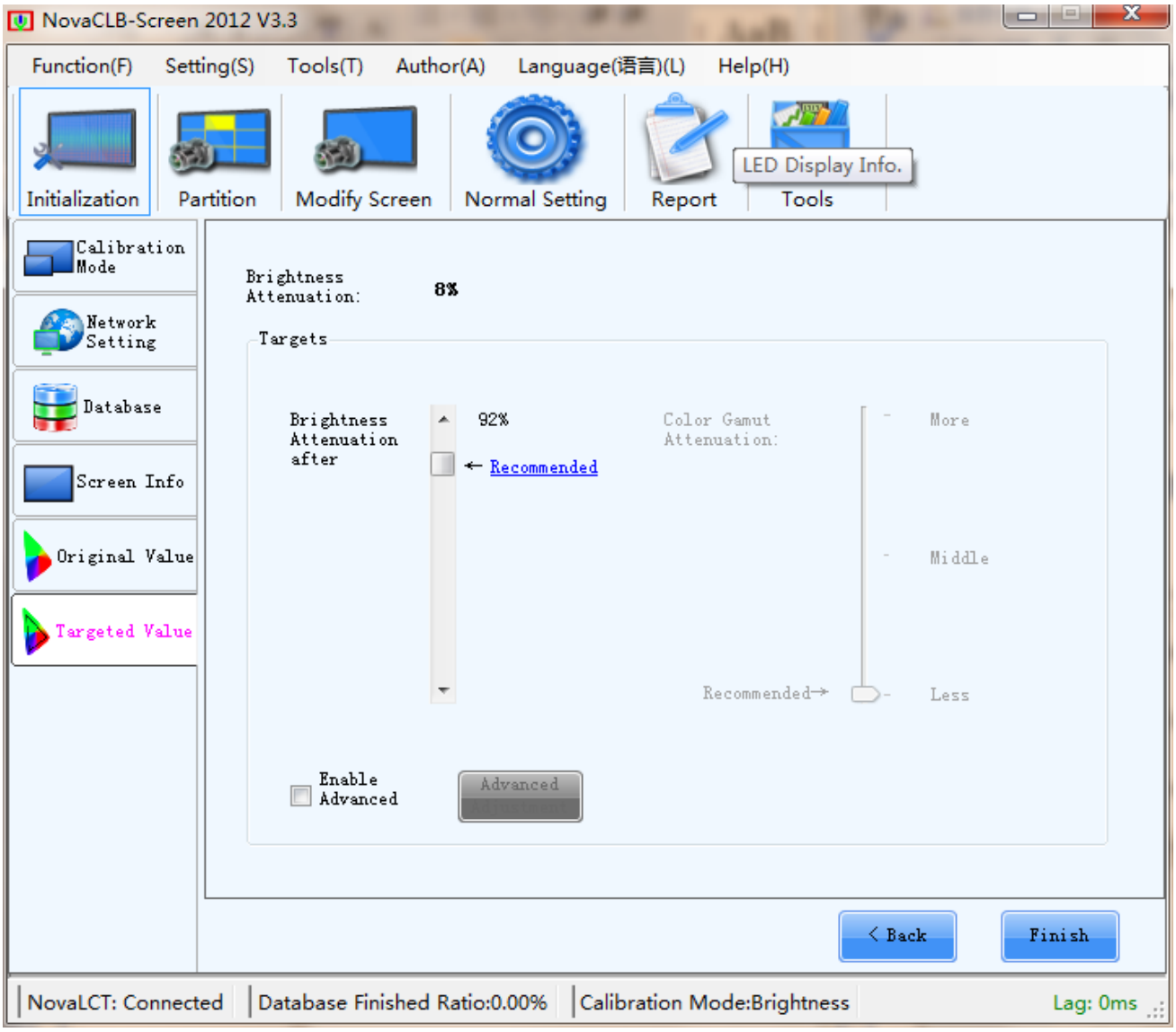
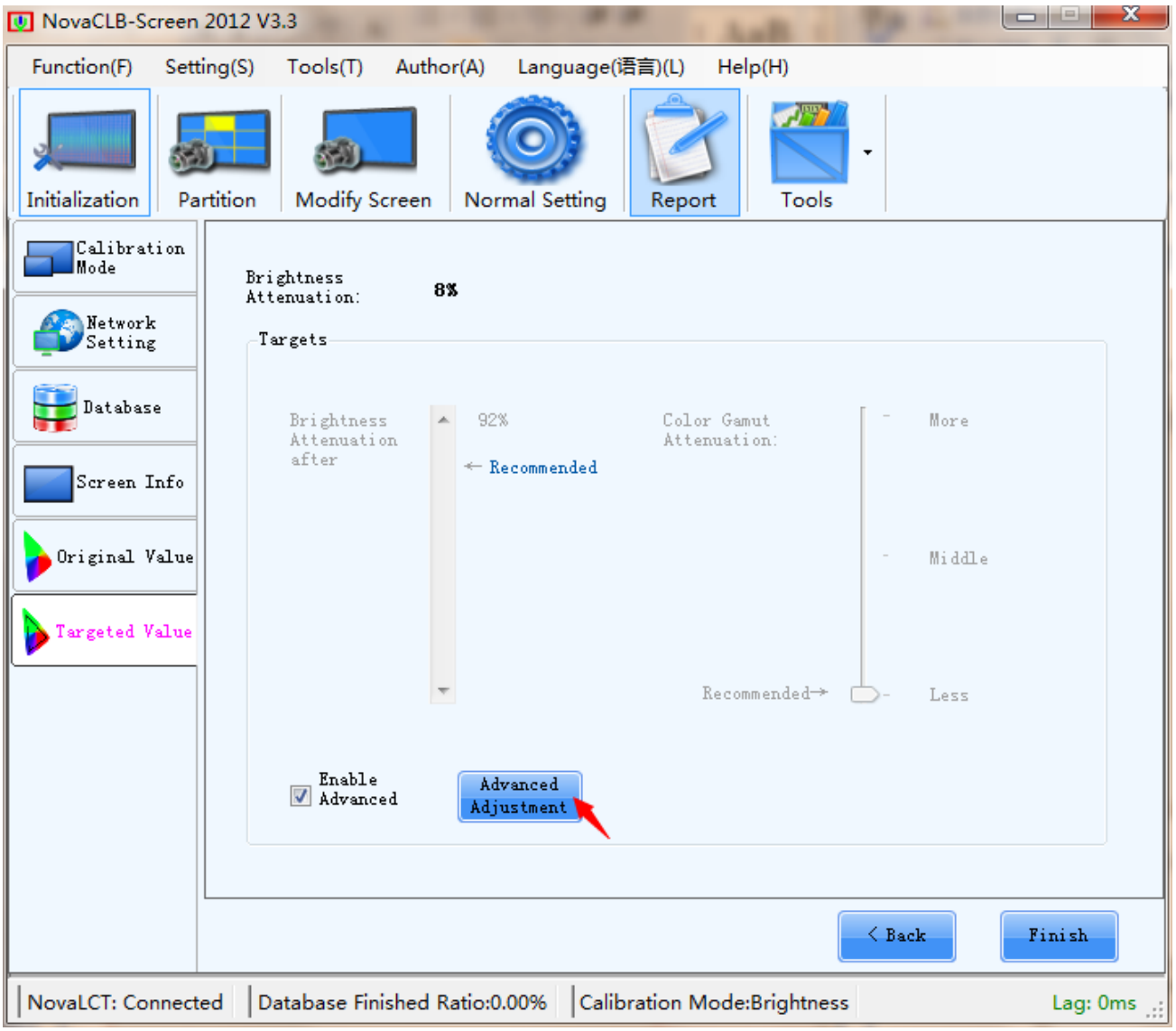


Fig.3-17 Brightness Calibration Interface of Target Brightness and Color Settings

Adjust vertical bar in the image above, choose an appropriate brightness attenuation value, the recommended value is 92%. This adjustment is the common attenuation of R, G, B. If the separated adjustment is needed, check "Enable Advance" and click "Advanced Adjustment" button. Then, it gets into advanced settings interface Fig.3-18 and Fig.3-19.



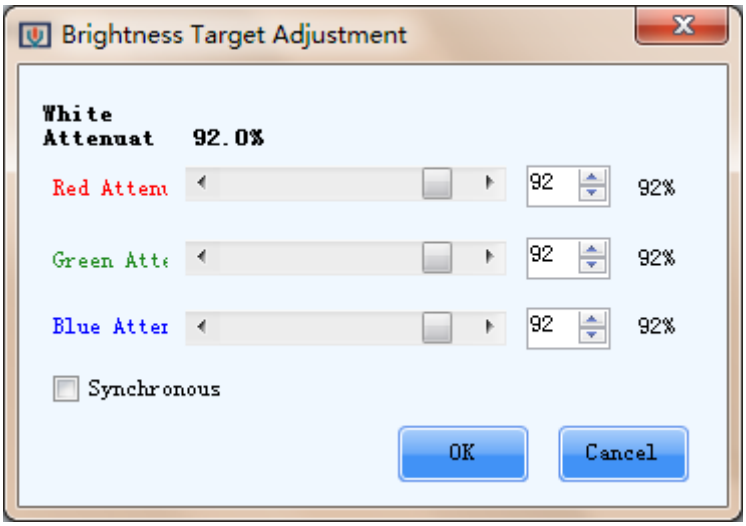


Fig.3-18 Brightness Attenuation Adjustment without Colorimeter

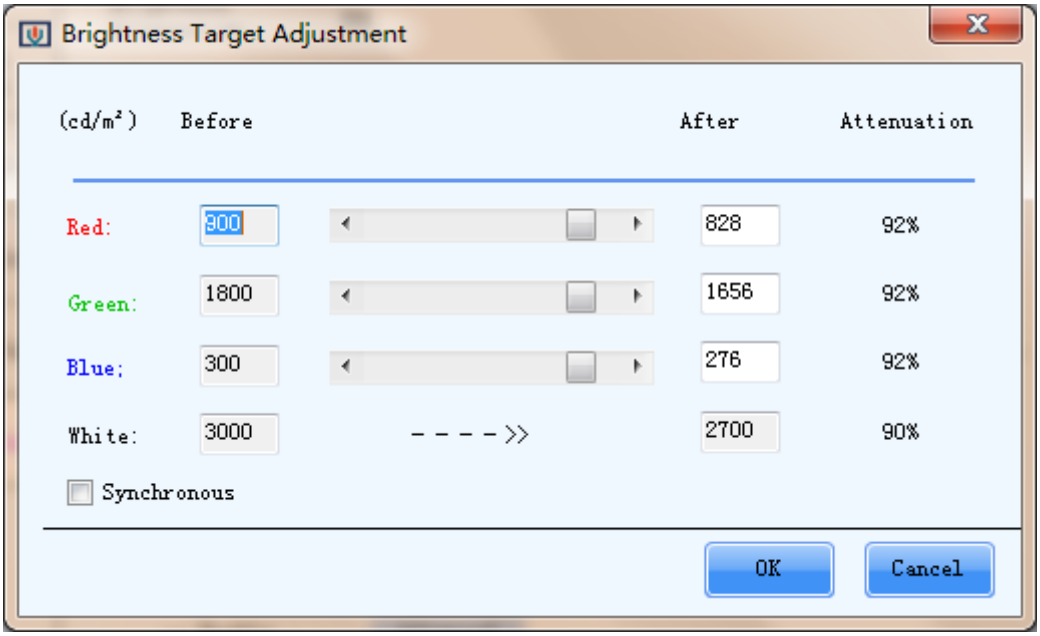


Fig.3-19 Brightness Attenuation Adjustment with Colorimeter

3) Brightness and Color Calibration

If users choose "brightness and color calibration", it will show as Fig.3-20.

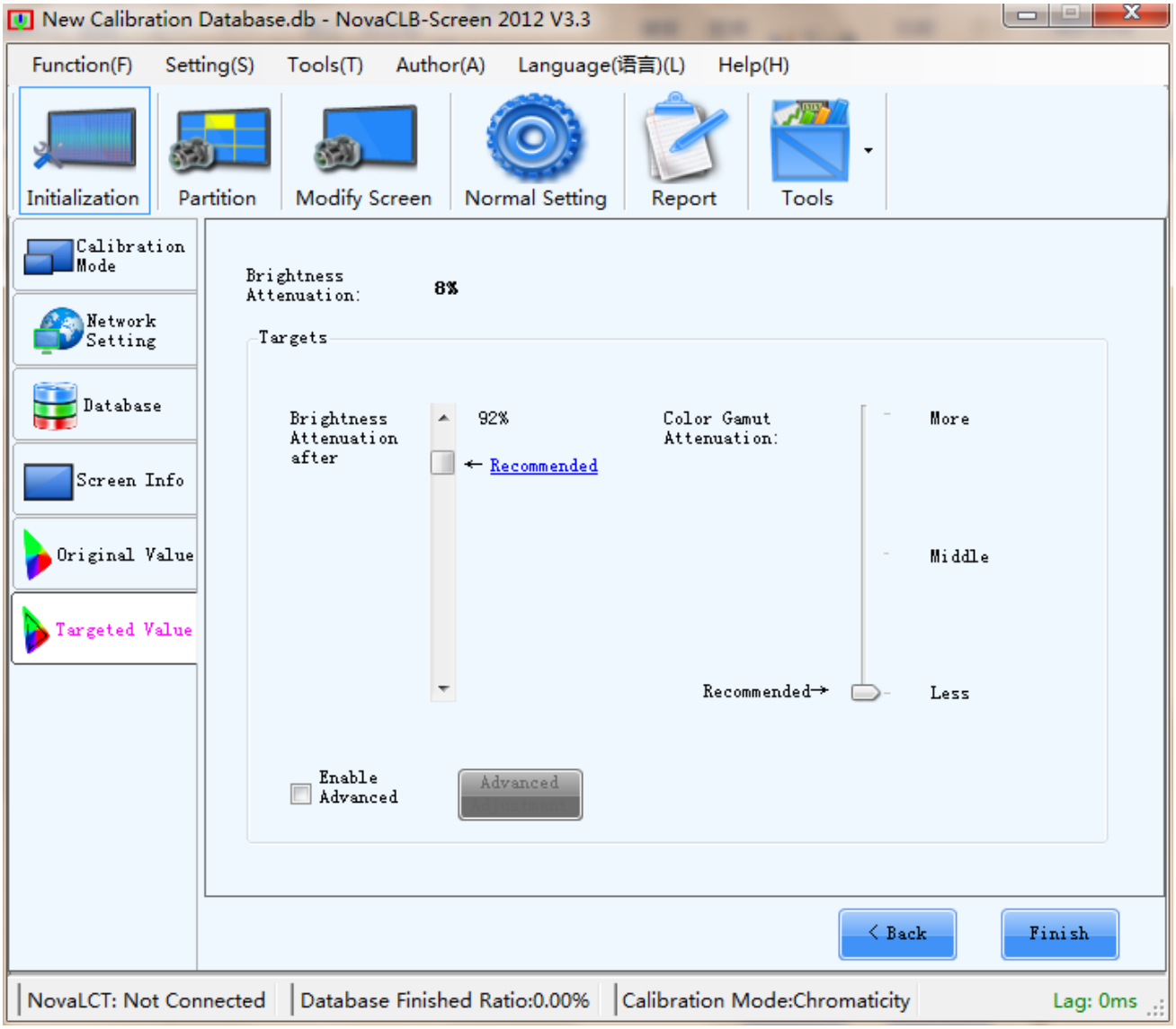
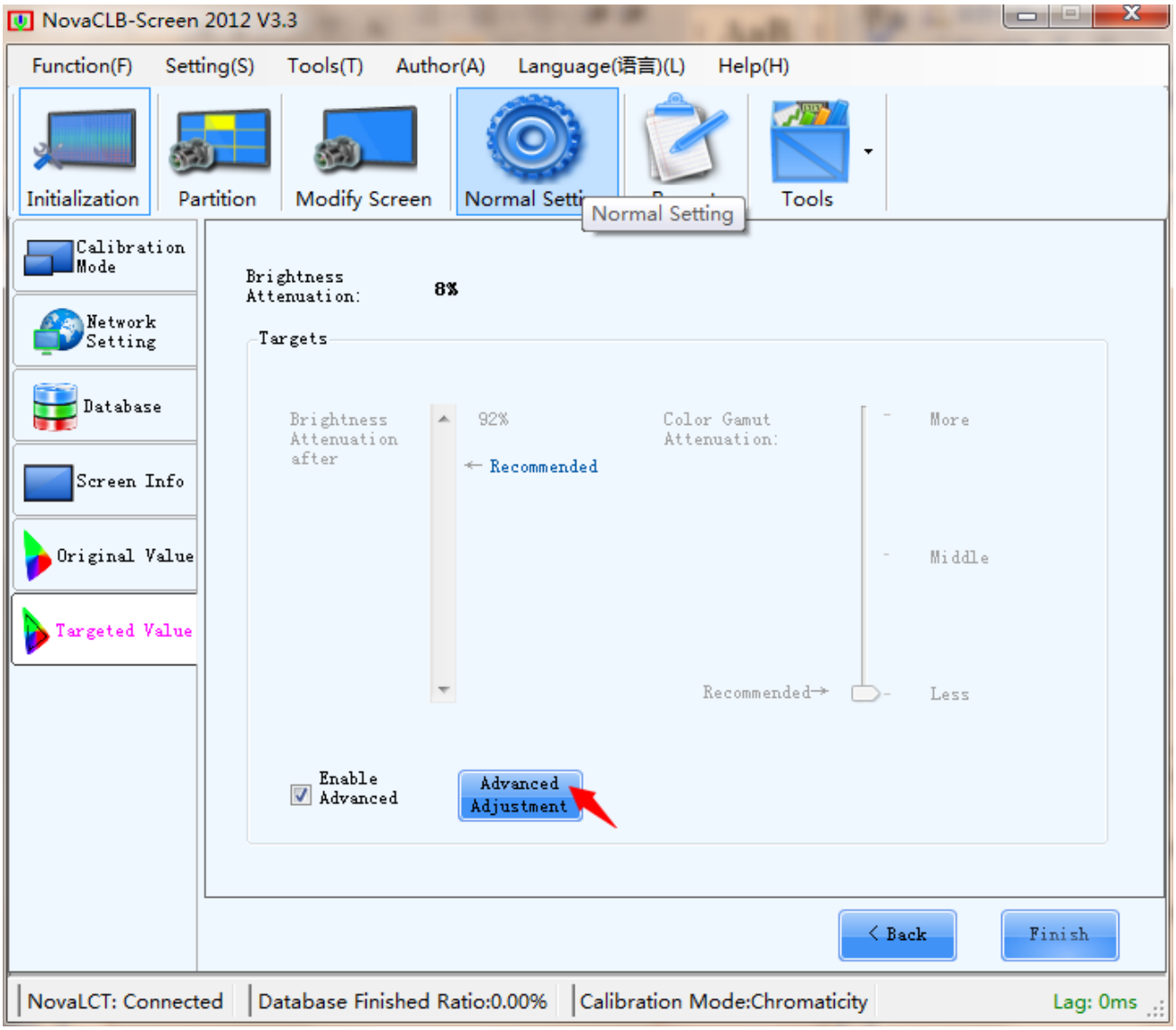


Fig.3-20 Brightness and Color Calibration Interface of Target Brightness and Color Settings

Adjust vertical bar in the image above to simply adjust the brightness and color, the recommended value is 90%. The color gamut attenuation can be divided into three grades: Low, Middle, High, the "Low" is recommended. But if the uniform of display is very bad or users want a high uniform, "Middle" or "High" can be chosen. If detailed settings are needed, users could get into advanced interface as Fig.3-21.



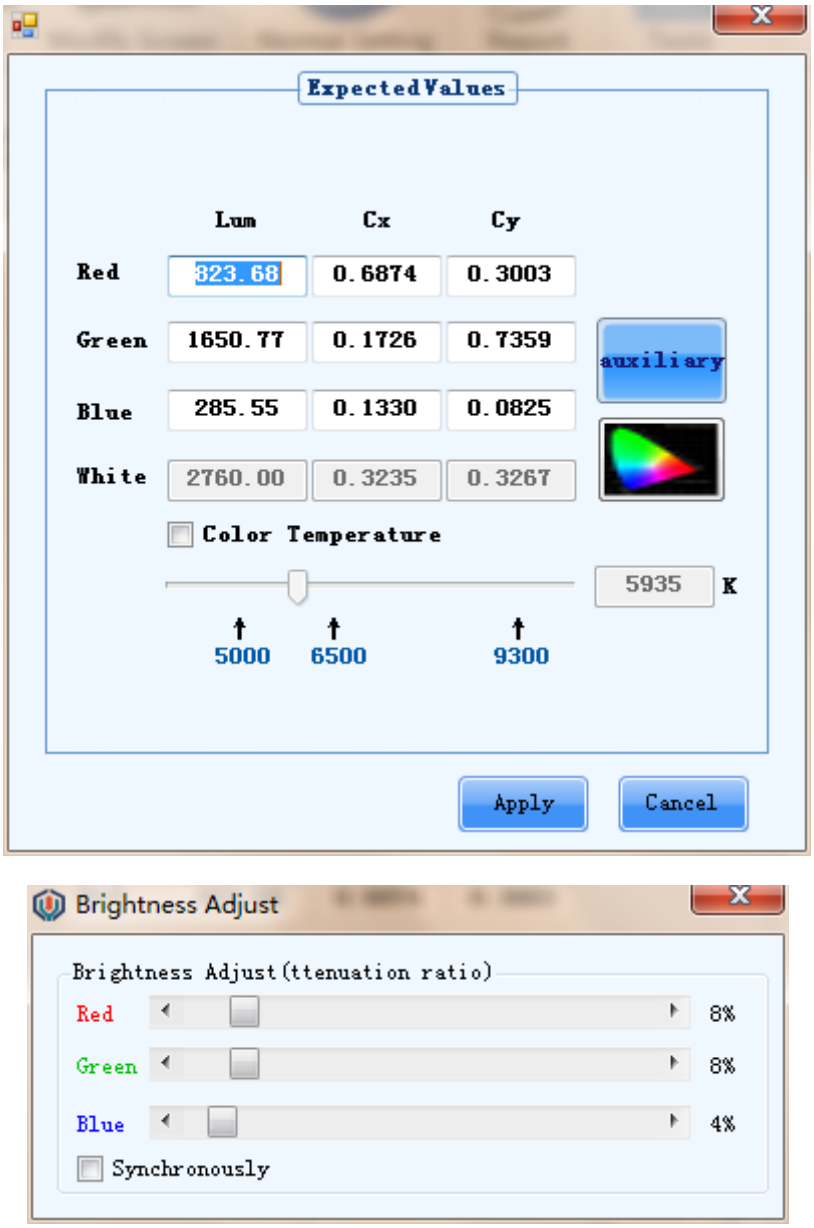


Fig.3-21 Advanced Settings Interface of Brightness and Color Calibration

In the image above, users can adjust target brightness and color value by the 

on the right, also users can input values in the textbox directly. Recommend using the first method

After adjustment, click  button to look up the current brightness and color value in CIE 1931 Color Diagram.

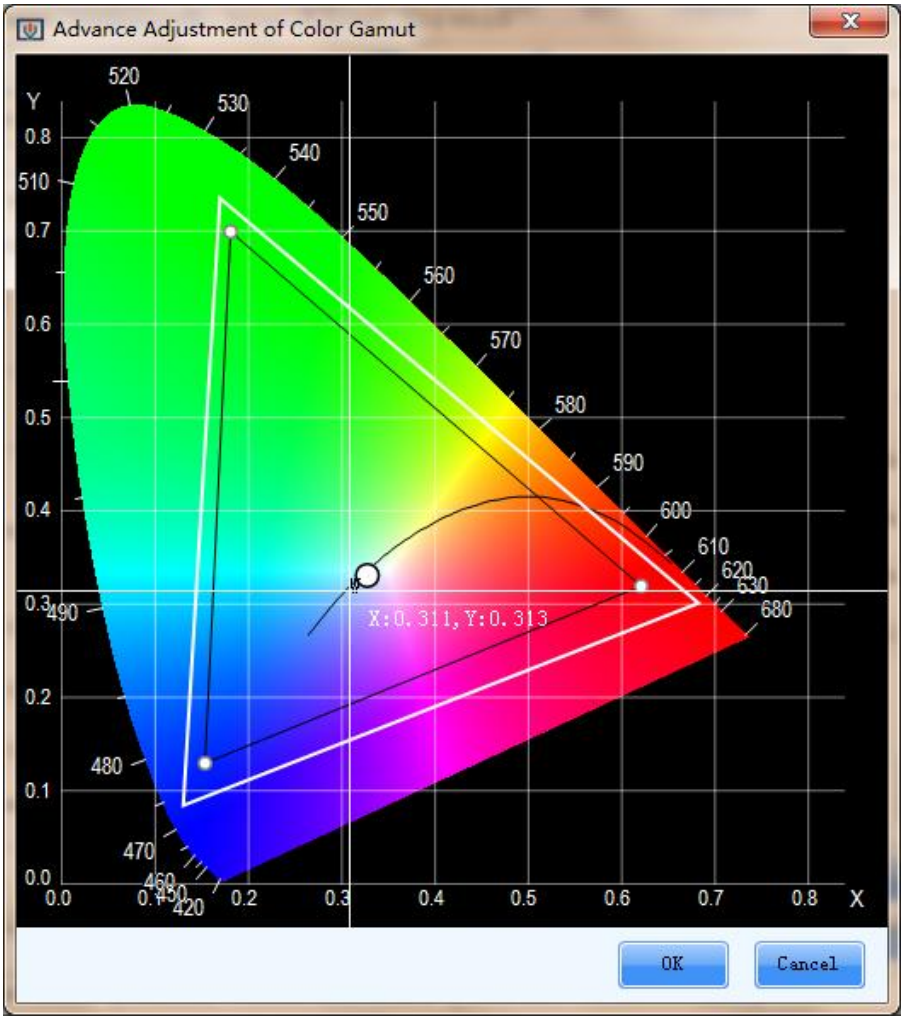


Fig.3-22 Measuring and Target Color Gamut in CIE 1931 Color Diagram

✧ Original Color Gamut

It is corresponding to "Original Brightness and Color" in software.

✧ Targeted Color Gamut

It is corresponding to "Target Brightness and Color" in software.

The white triangle in the image is corresponding to measuring color gamut, the black triangle is corresponding to target color gamut. To realize the uniformity after calibration, the target color gamut should less than measuring color gamut. From the image above, users can get the attenuation of color gamut. Users can also click the right mouse button in Color Diagram to choose adding the color coordinate to "Target Brightness and Color" value.

The former method is recommended.

Users can also check “Color Temperature” and directly enter an appropriate color temperature value，or drag the bar to set color temperature value, or click to use the recommended color temperature value, where three commonly used color temperature values are provided: 5000K, 6500K, 9300K.

Note: The prerequisite for using this method is that the original red, green and blue brightness and chromaticity values (for example, brightness and chromaticity values shown in Fig. 3-13 and Fig. 3-14) must be accurate values measured by the light gun.

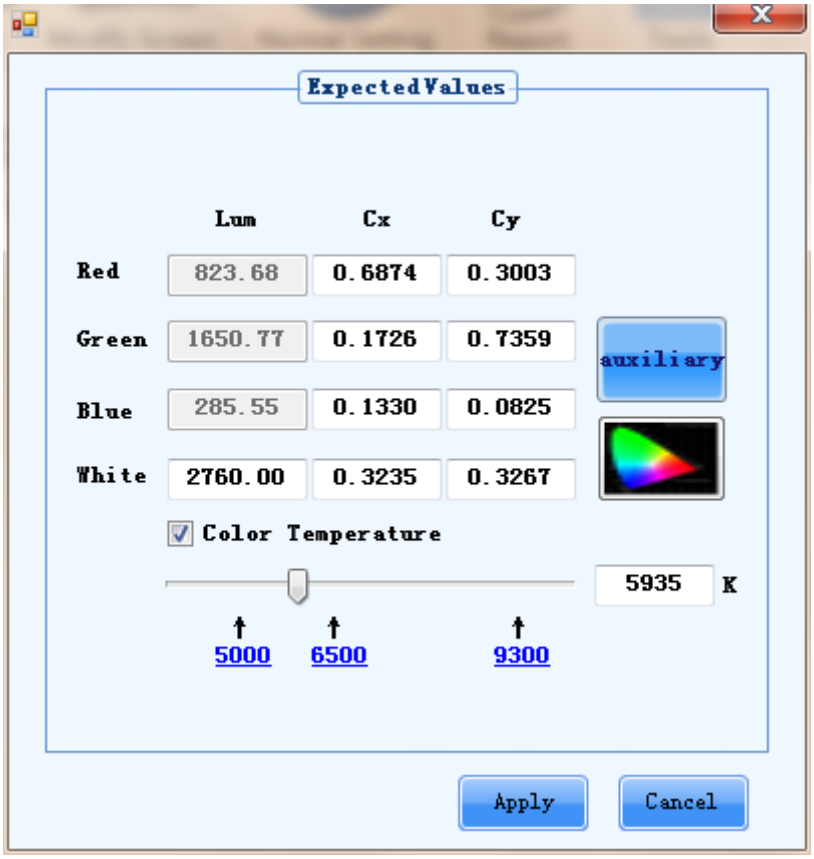


Fig.3-23 Expected Color Temperature

3.3 Partition calibration

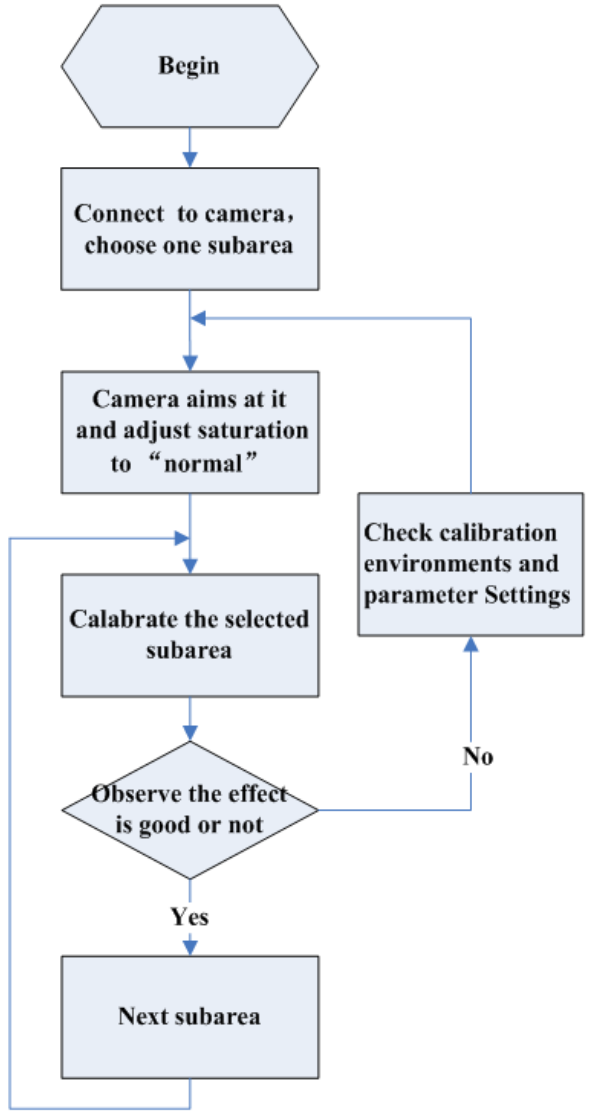


Fig.3-24 Partition calibration Flow Diagram

Partition calibration is the process of realizing screen calibration when calibration parameter settings are finished.

3.3.1 Partitions

"Partitions" here is regarded as a verb-divide. Consider the constraint of the size of camera lens, the screen need to divide into several proper subareas to calibrate.

3.3.1.1 Normal Partition

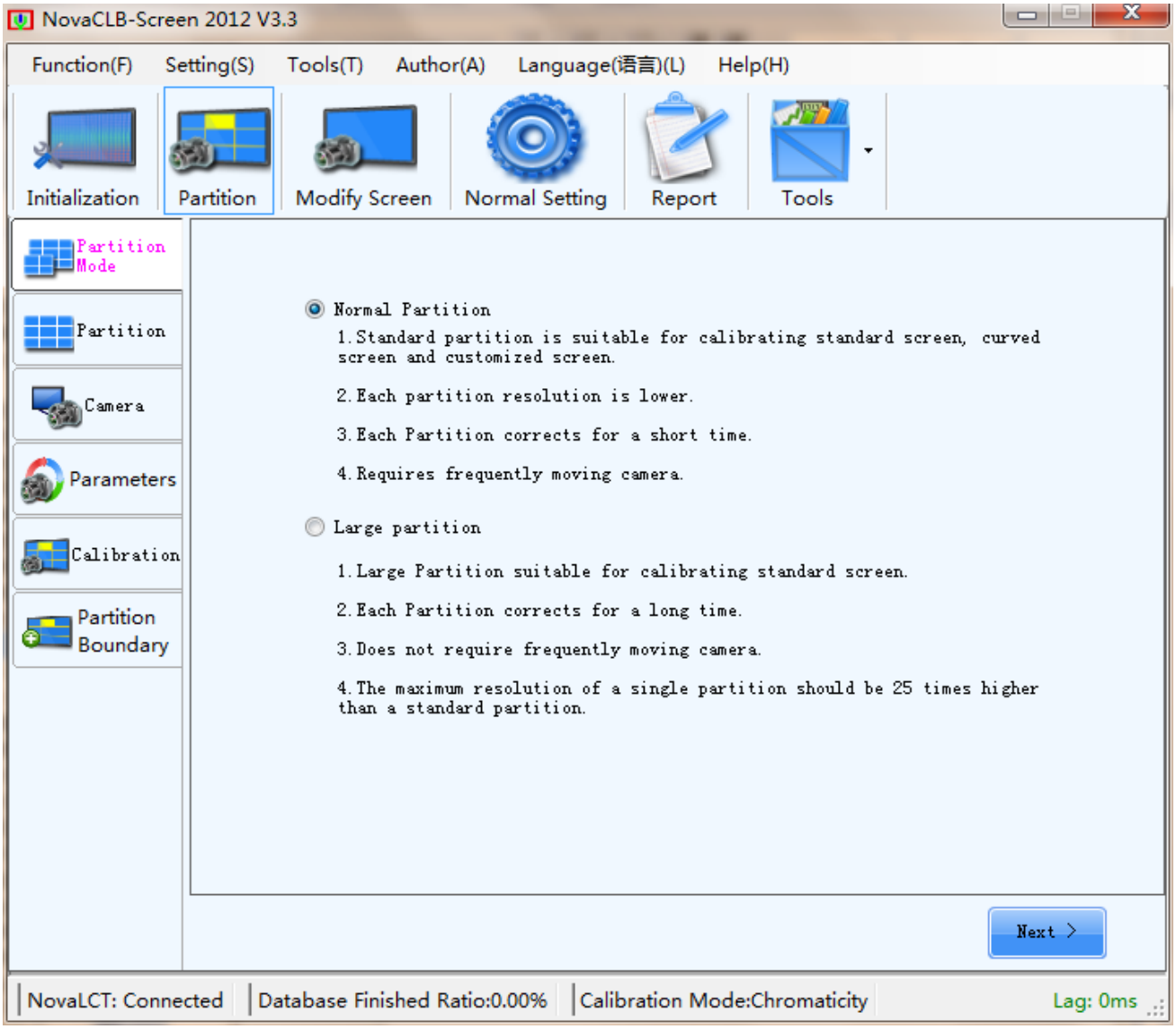


Fig.3-25 Page Of Partitions

Due to the limitation of the camera's resolution, the screen needs to be divided into several proper subareas to be calibrated.

Single subarea rows and columns settings may refer to the top of the recommended partition size, generally speaking, 192 x 128 is more appropriate.

It is advised to check “Eliminate the boundaries of the Partitions” to eliminate differences among partitions.

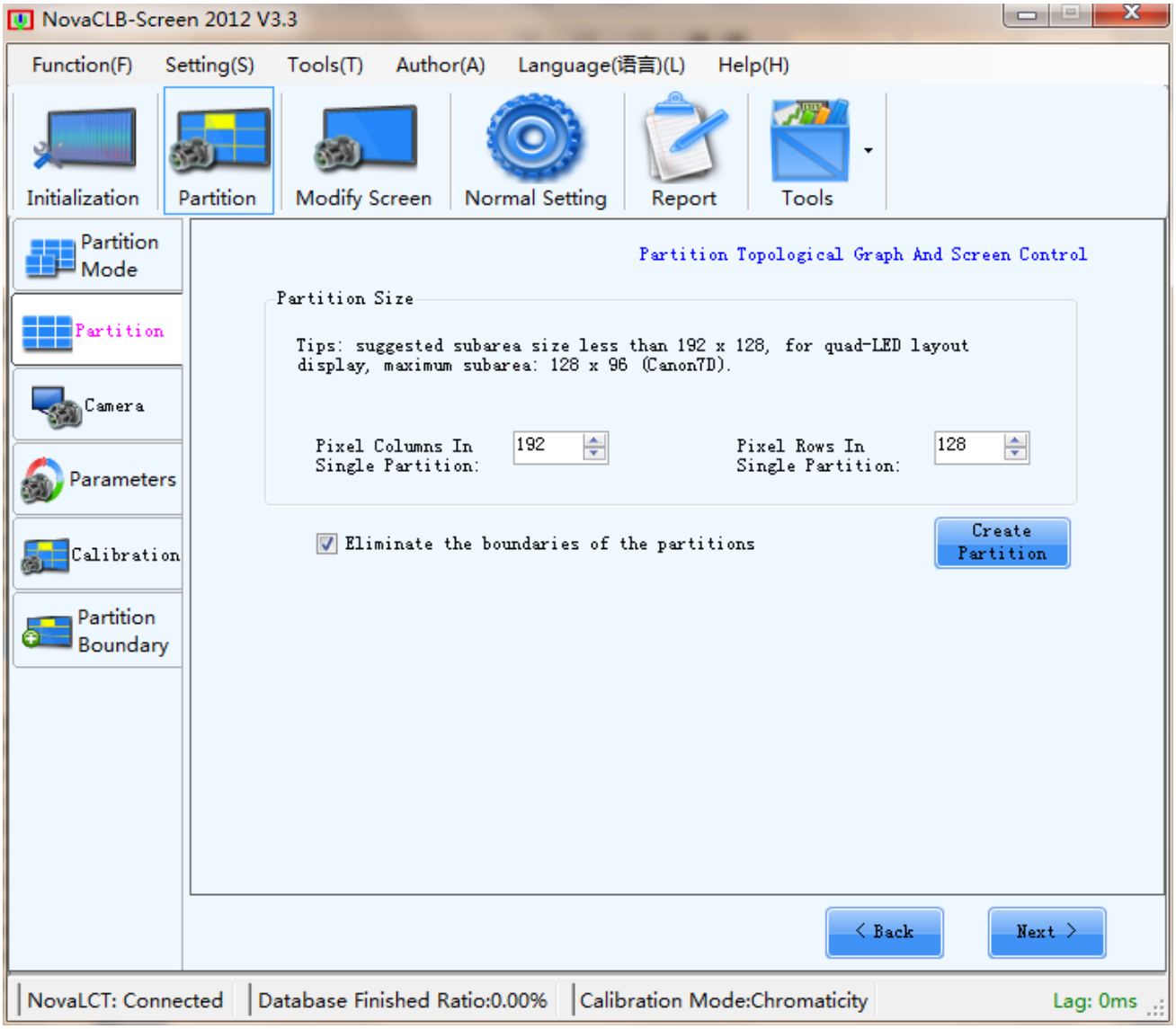


Fig.3-26 Parameter Setting of Normal partitions

When finished, click "Create Partition", then you can see the result as shown in fig 3-27.

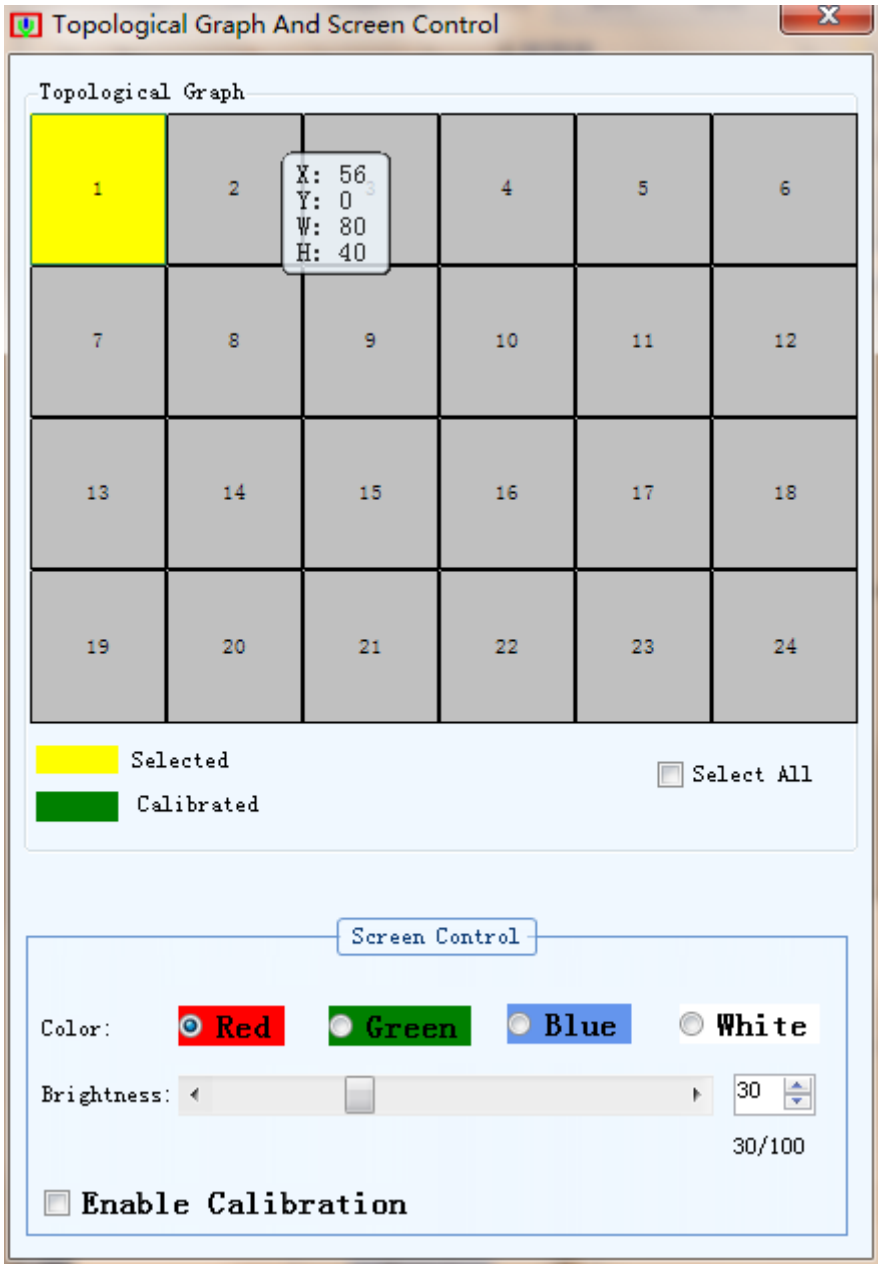


Fig.3-27 Topography Graph And Screen Control Window

✧ Topography Graph

It is composed of divided subareas, and number these subareas from left to right, from top to bottom.

✧ Screen Control

It is used to realize the control of screen color, brightness and division switch.

The right window can move together with the main window, and can shut down when unnecessary. Click "Topological Graph And Screen Control" on the right page, it will popup.

After division, click "Next", enter into "Connect to camera".

3.3.1.2 Large partition

Compared to normal partition, large partition features that the correction area is several times larger than normal partition. For example, if the unit number is set as 5×5, the maximum correction area is 224×5,150×5 when the camera adopts large partition. To ensure the quality of the image, the recommended partition is 192×5,128×5.

If large partition calibration is adopted, full-screen calibration is no longer necessary.

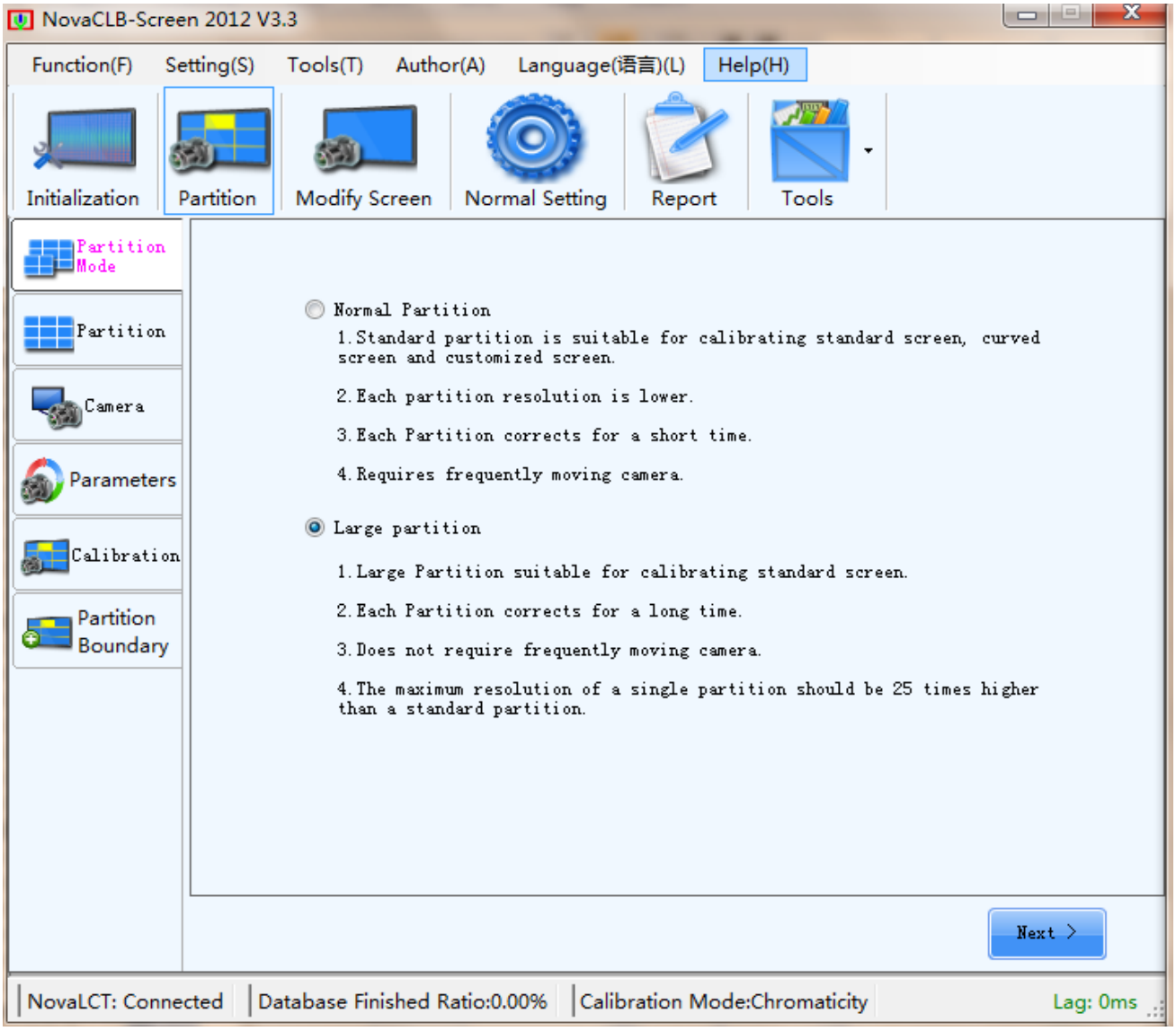


Fig.3-28 Large partition

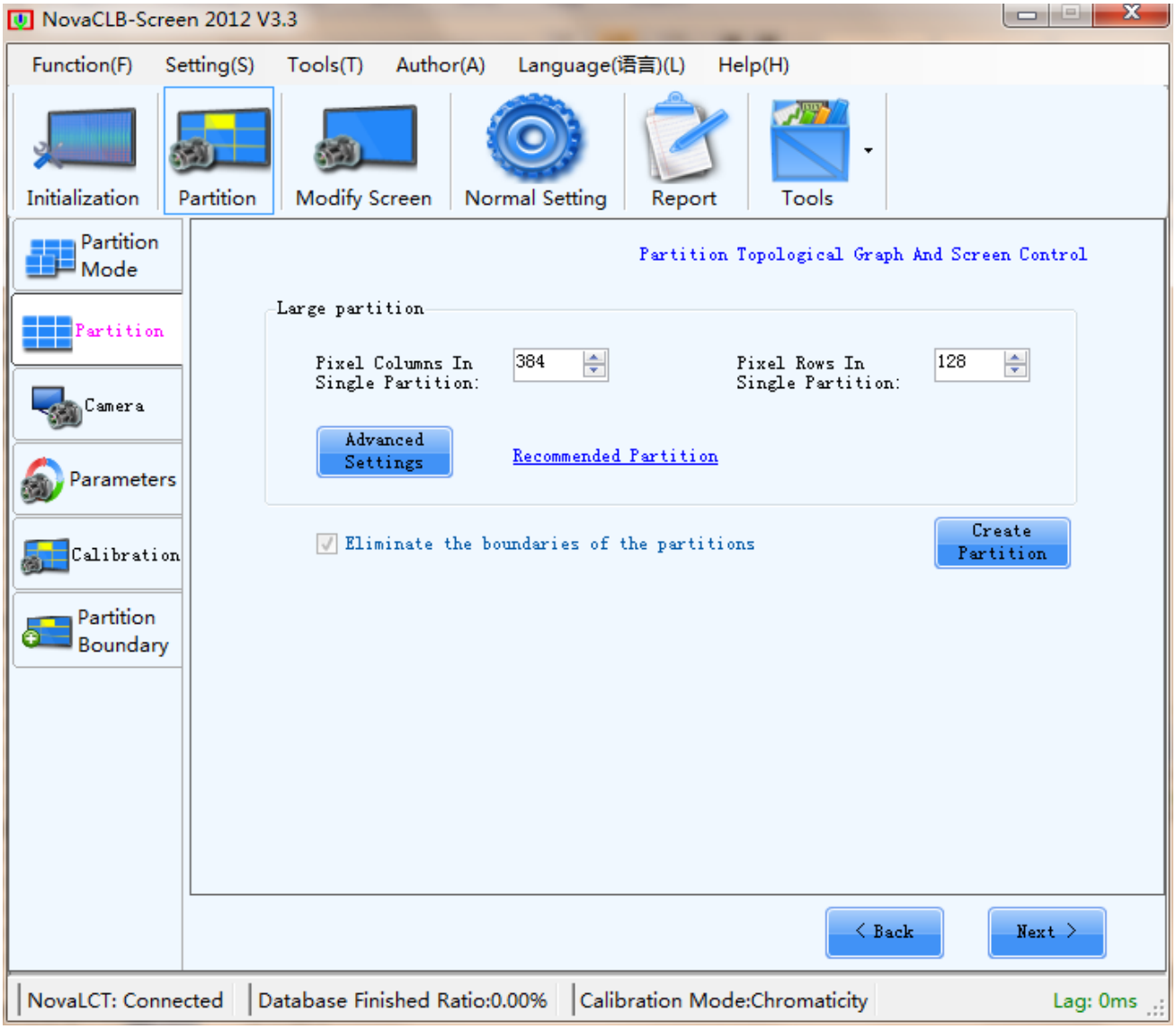


Fig.3-29 Parameter Setting of Large Partition Calibration

Click Recommended Partition , where the software calculates the pixel size of a properly single partition according to the screen size. Then click Create Partition.

If the recommended partition is not adopted, click Advanced Settings to set the size of the unit, where columns and rows collected by the camera cannot exceed the default value "224×150", and the partition size (unit columns and rows ×columns and rows collected by the camera) is displayed at the bottom of the interface. After setting is finished, click OK, and then click Create Partition.

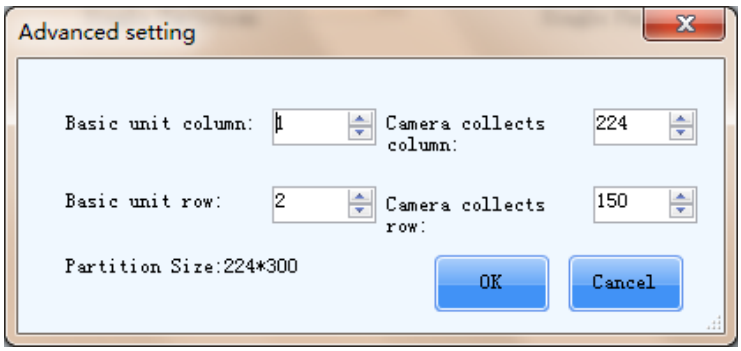


Fig.3-30 Advanced setting for basic unit

3.3.2 Connect To Camera

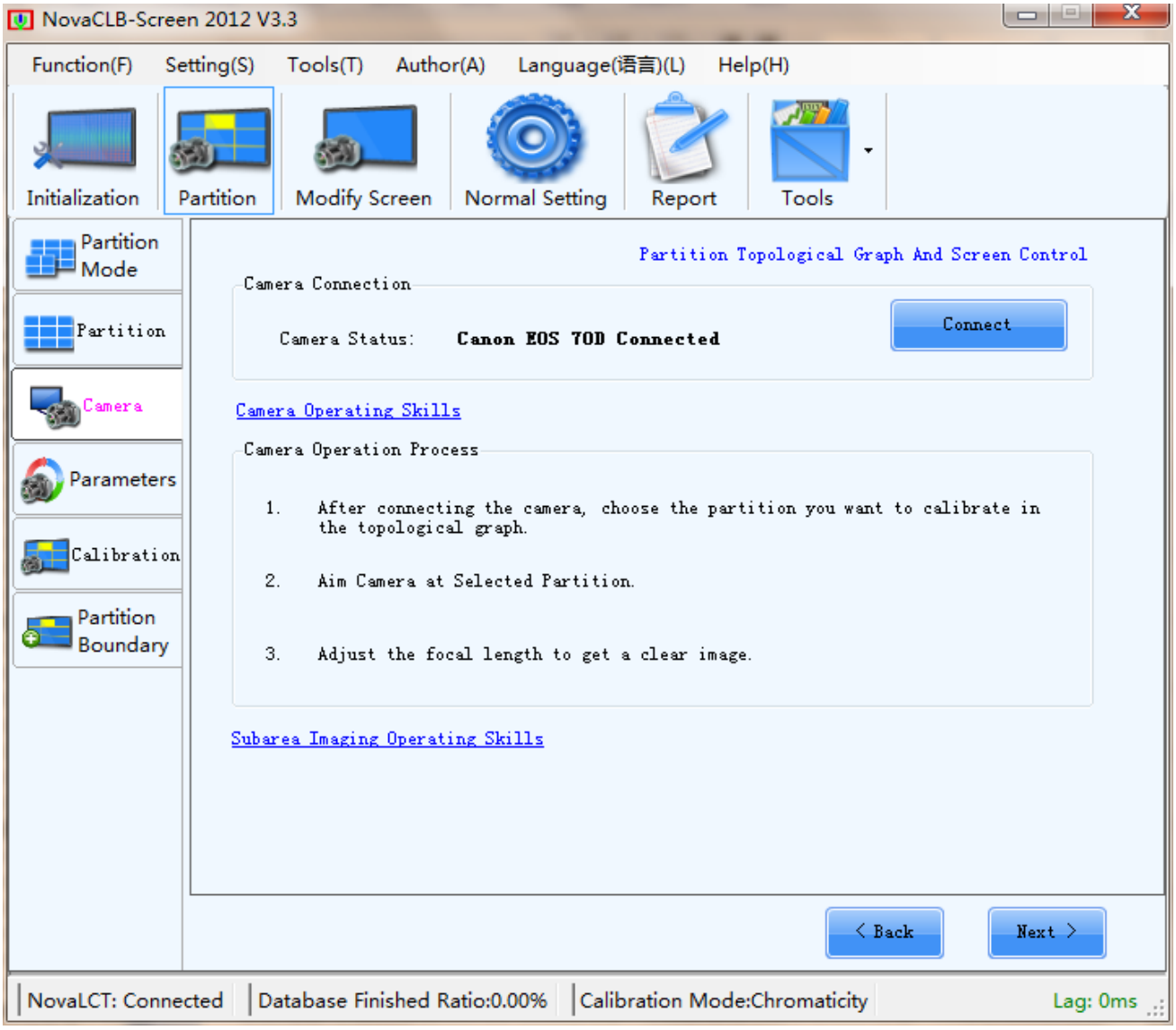


Fig.3-31Connect To Camera

When succeed in connecting to camera, the interface appears as fig 3-31show. You can click help

documents on the left to obtain some camera operating skills and partition imaging techniques.

3.3.3 Camera Parameters

No matter manual mode or automatic mode is adopted, adjust the saturation till the result reaches "Normal", and adjust the image size to "Fit", make sure the adjusting result of the saturation to be normal, and during this process, make sure that the camera faces to the partition. Large partition.

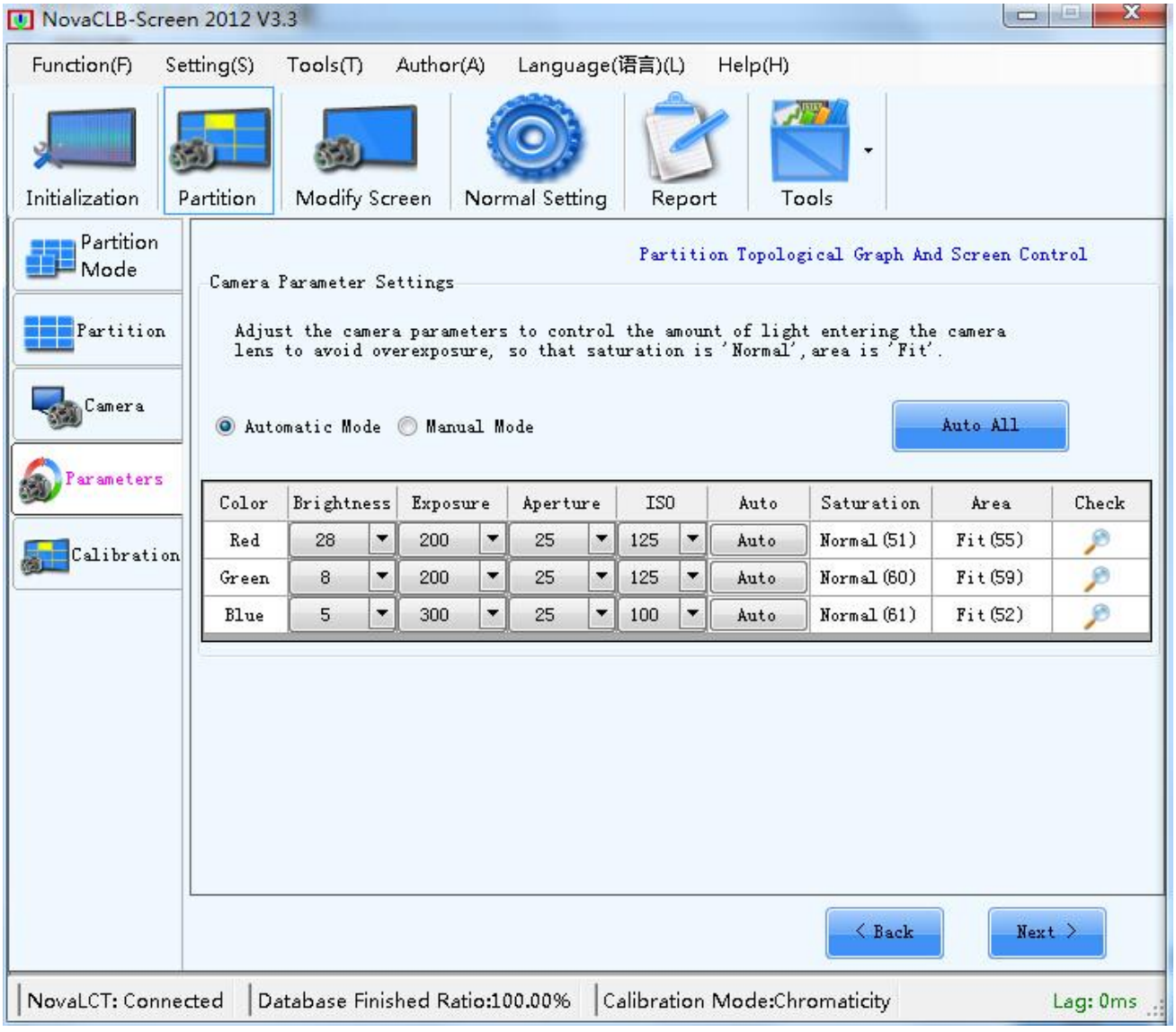


Fig.3-32 Camera Parameters

✧ Automatic Mode

This mode is the default mode. Under this mode, users just need to click on "Auto All" button,

then the software will automatically analysis and adjust the saturation, finally achieve "normal". If failed, please check the calibration environment and parameters, then try again.

If it is offline mode, the below dialog would be shown when clicking 'Auto' or 'Auto All' button. Please go to LCT offline calibration interface according to the tips.

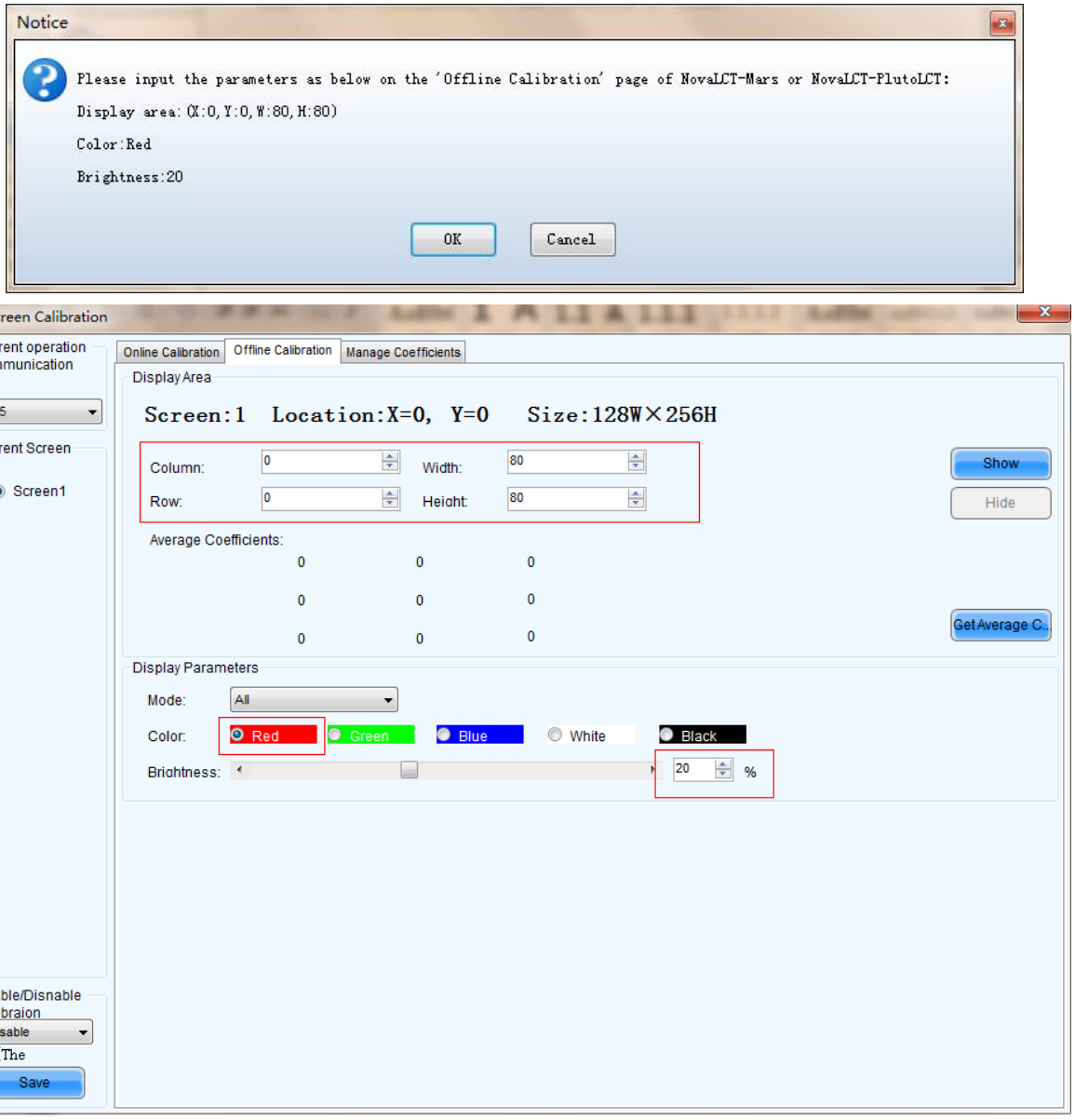


Fig.3-33 Set display parameters

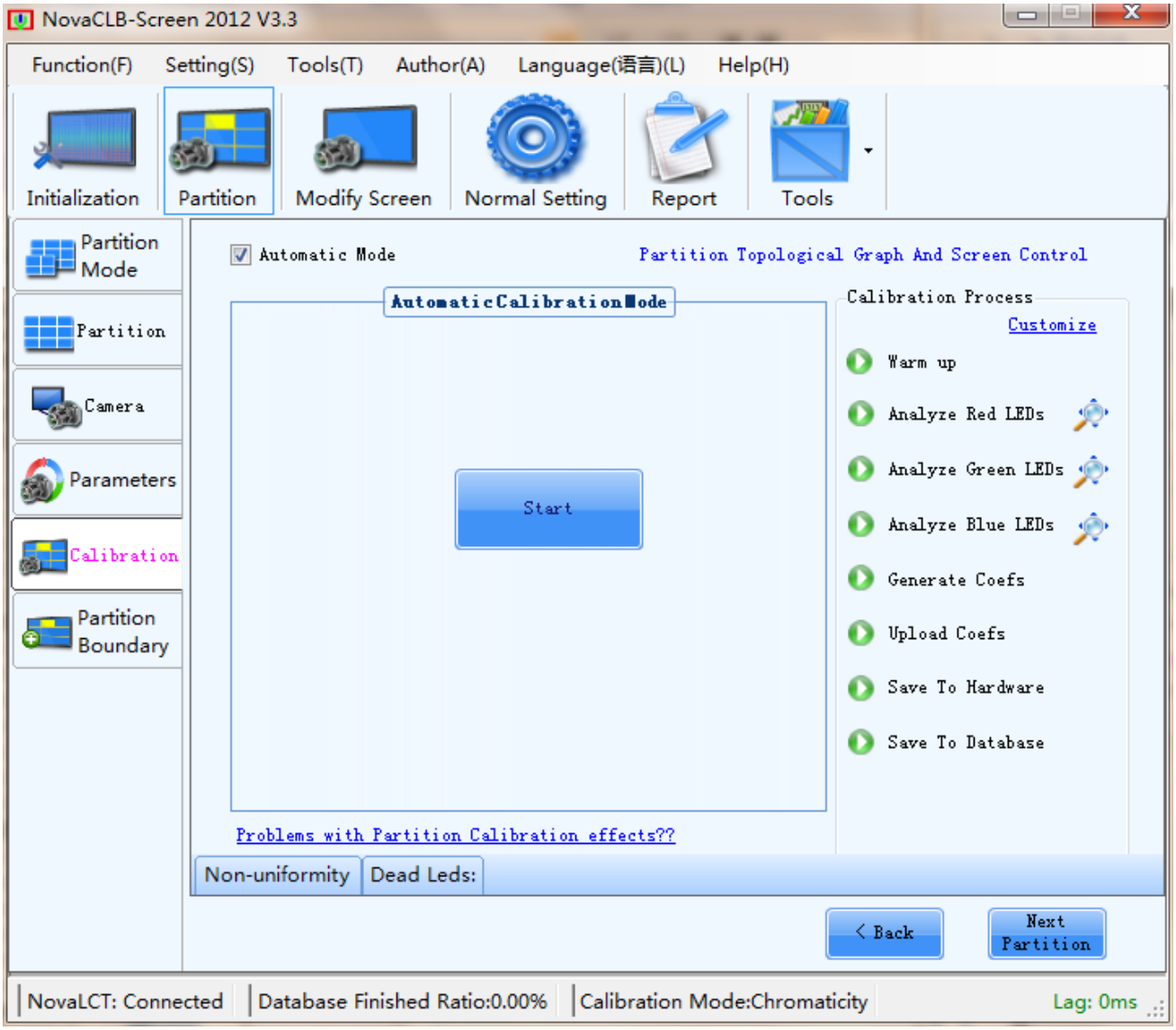
✧ Manual Mode

Under this mode, users should adjust calibrate brightness, exposure time and aperture size. When adjusting, give priority to "aperture", followed by "exposure", and finally "brightness".

Attention: The default brightness under large partition mode is 50, and the routine partition is 30. Automatic analysis is advisable. Manual adjustment can be carried out if experienced. Next step can be taken only if the analysis result is normal. Saturation between 30 and 100 is normal , it is proper to adjust the image size to 50.

You can click  to view the image obtained after saturation adjustment, in order to help find problems. When red, green, blue analyses are all completed, click "next" to enter into the page "Partition calibration".

3.3.4 Partition Calibration



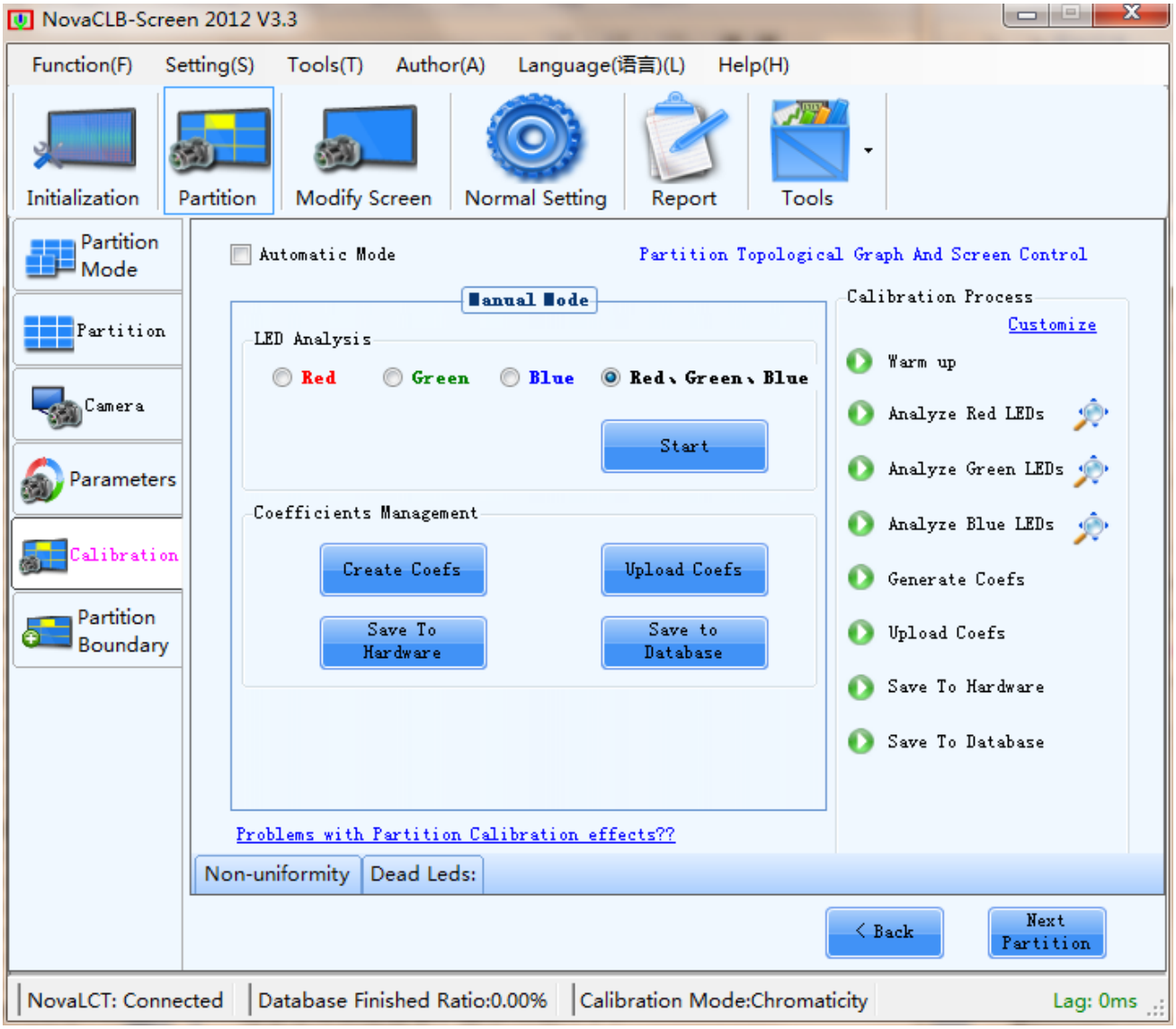


Fig.3-34 The Calibration Page

Normal partition supports gap calibration and coefficients uploading stably; Large partition supports enabling gap calibration, system uploading stably and background off. And the operating method is as follows:

Before enabling automatic calibration, click "Normal Settings" at the main interface to pop out the following window (the setting interface for the big partition), tick the corresponding option, click "OK".

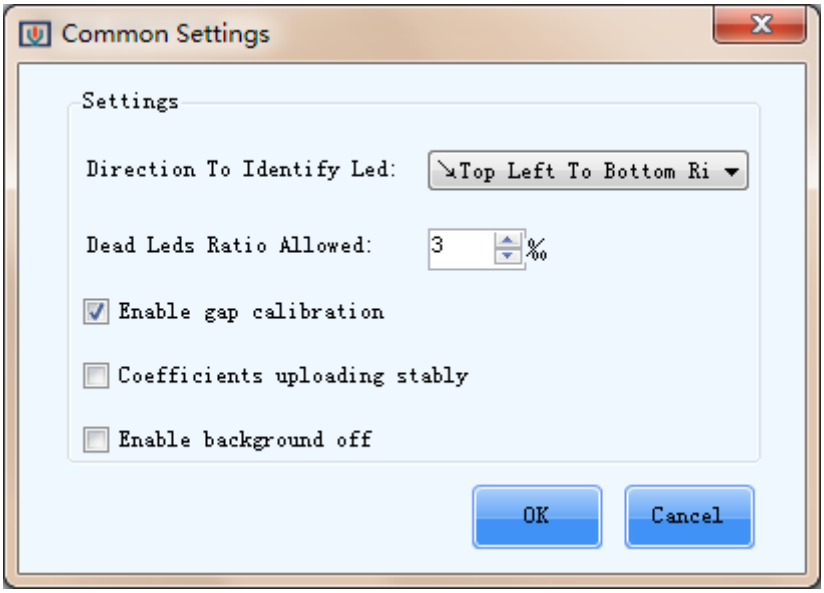


Fig.3-35 Normal settings for large partition

✧ Enable gap calibration

This is an option enabled when Normal partition calibration.. Gap calibration is mainly used for small pixel pitch LED displays calibration, to solve the bright and dim line caused by cabinet assembly. Note: bright and dim line must be inside Partitions.

Click "Normal setting" on the main menu to pop up the window below, and then check "Enable gap calibration".

✧ Coefficient uploading stably

Coefficient uploading stably means to upload calibration coefficient via serial cable, the speed is slower but stable. Default calibration coefficient uploading route is via DVI cable, the speed is faster. If there's something wrong with DVI cable, serial cable can be used as alternative by selecting coefficient uploading stably.

✧ Background off

Background removal is to remove background light, which is an option enabled when large partition calibration. Generally, calibration is required only to be conducted under relatively dark environment, but if background removal is enabled, calibration can be conducted even if the

environment is not dark enough.

After "Enable background off" is selected, the interface shown in Fig.3-36 is displayed. Users can use the mouse to drag the four vertexes of the quadrangle to select the valid area to be calibrated. The unwanted light around the screen to be calibrated is removed.

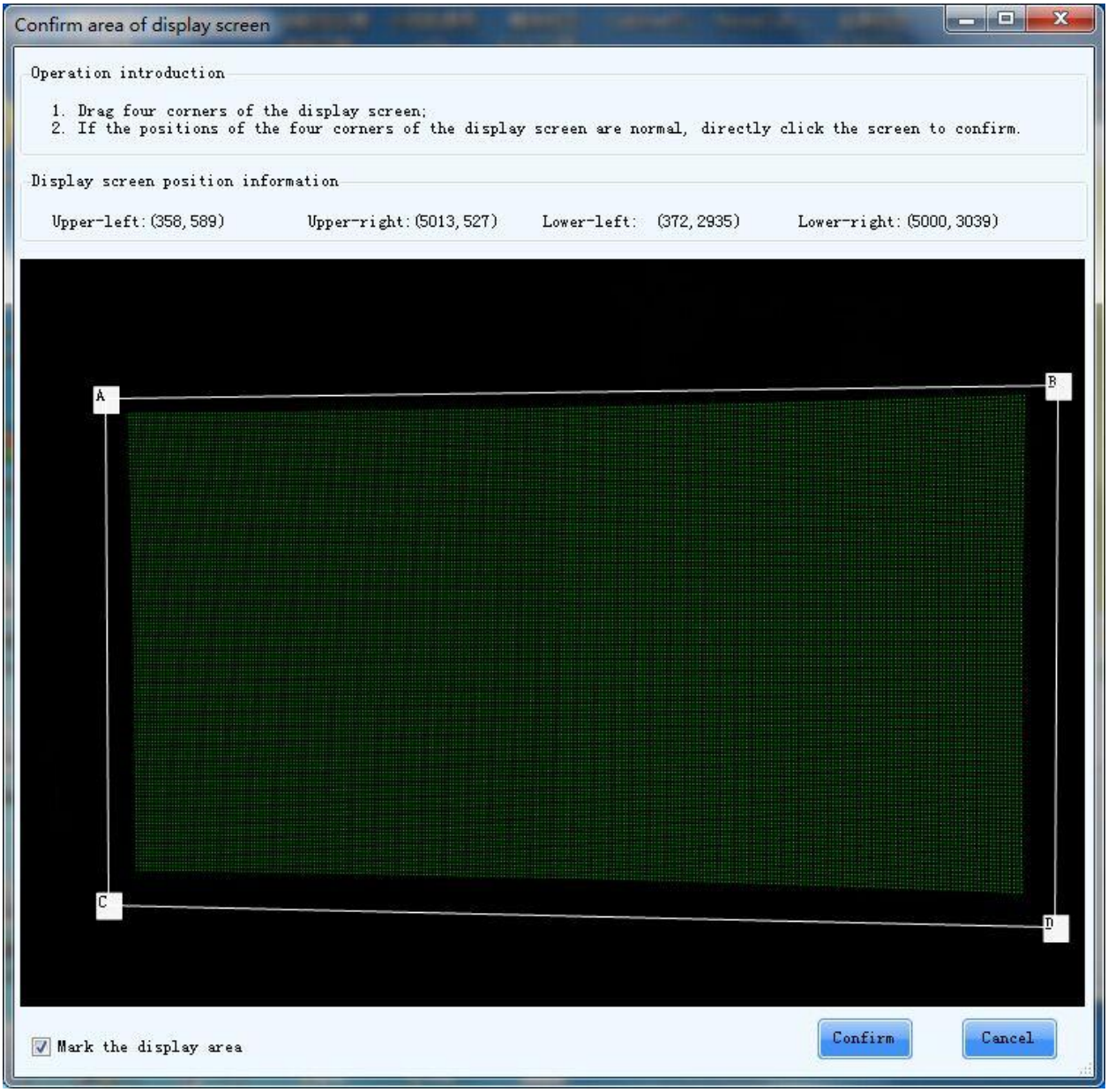


Fig.3-36 Screen Area Determination

✧ Automatic calibration Mode

Users just need to click "Start" button, the software can do the following things automatically: analyze red, green and blue led, generate coefficients, upload coefficients, save to hardware and

to database. It will make calibration more convenient and efficient. Users may also manage this flow according to their own requirements. Click "Customize" ,you can see fig. 3-37.

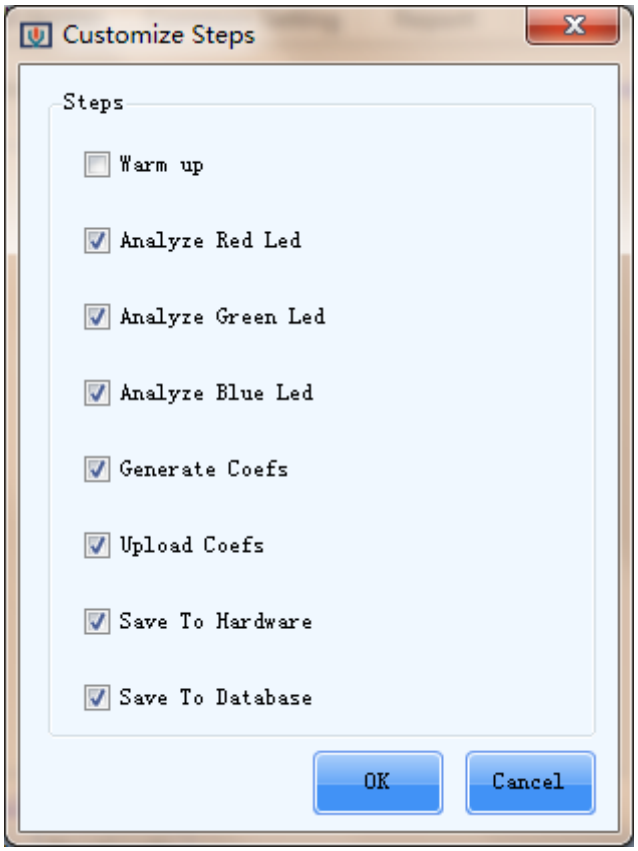


Fig.3-37 Customize Window

✧ Manual Calibration Mode

Users can separately operate every step of the calibration process.

For the partition is completed, users can test whether the calibration effect is good through "pictures control" on the right side of this window. If bad, click "Calibration effect is not good?" on the bottom left corner, check the help documents to help solve the problem. As shown in fig 3-38

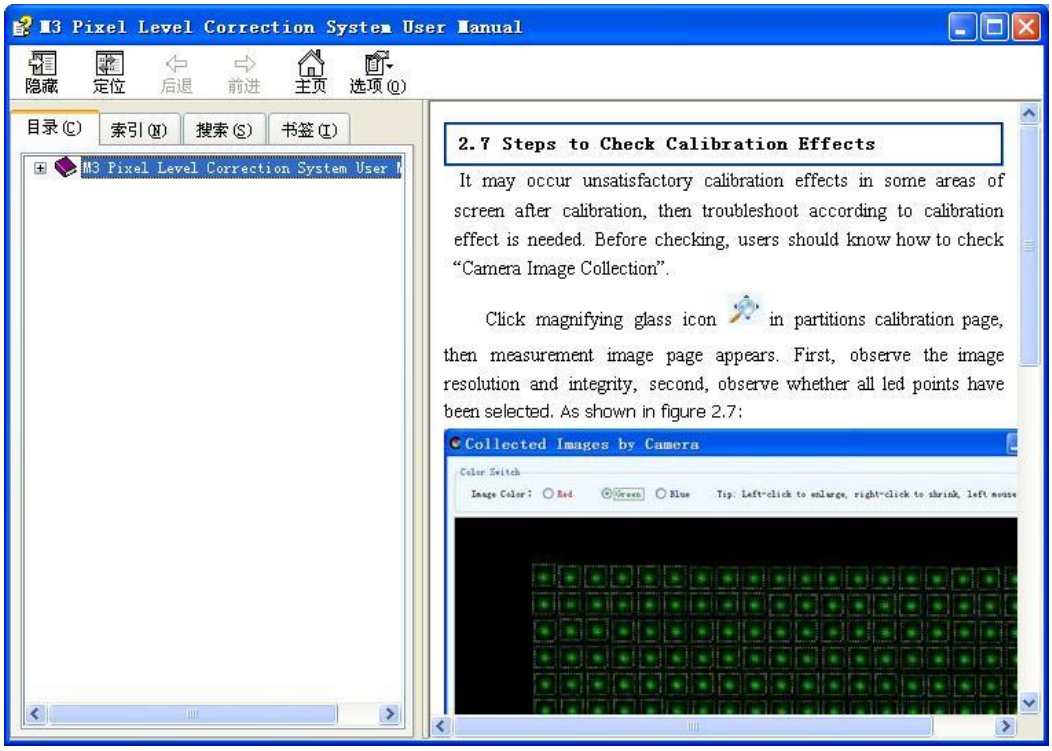
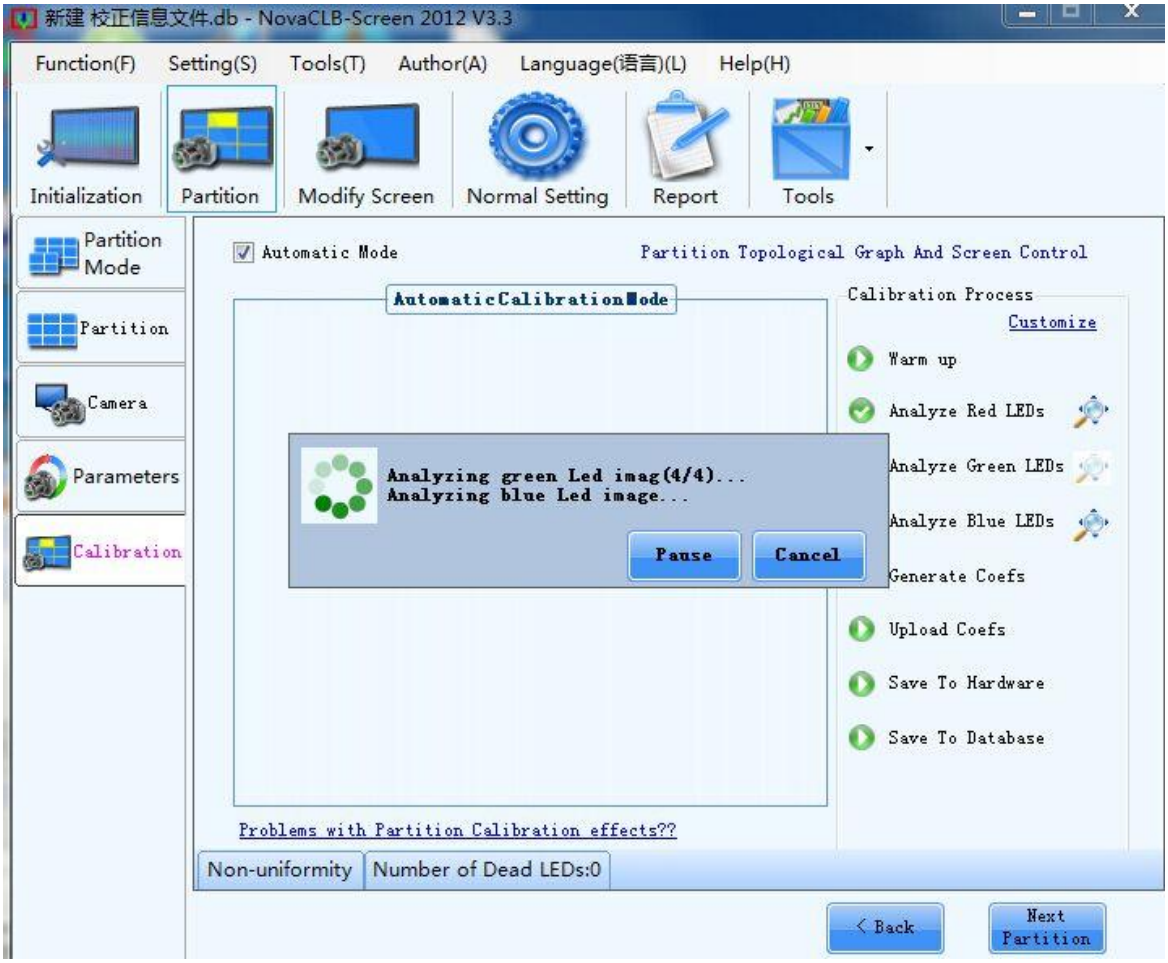
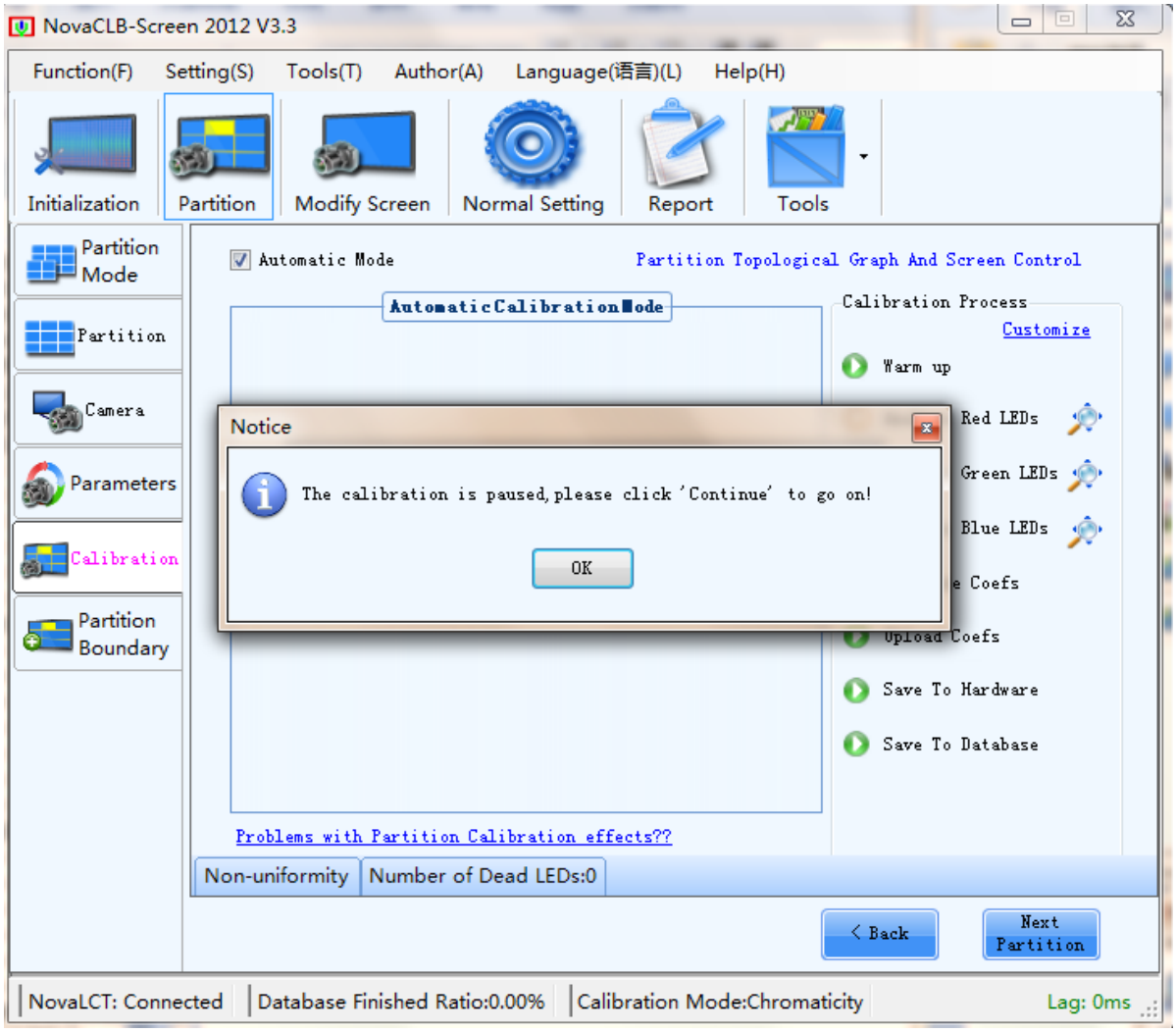


Fig.3-38 Steps to Check Calibration Effects

✧ **LED Identification Failure(**This function is available only in the large partition mode**)**

Some emergency situations may happen during the calibration process, such as sudden appearance of obstruction; user can click Pause to stop calibration under such condition. When user clicks Continue to continue calibration, the camera will start shooting from the last picture.





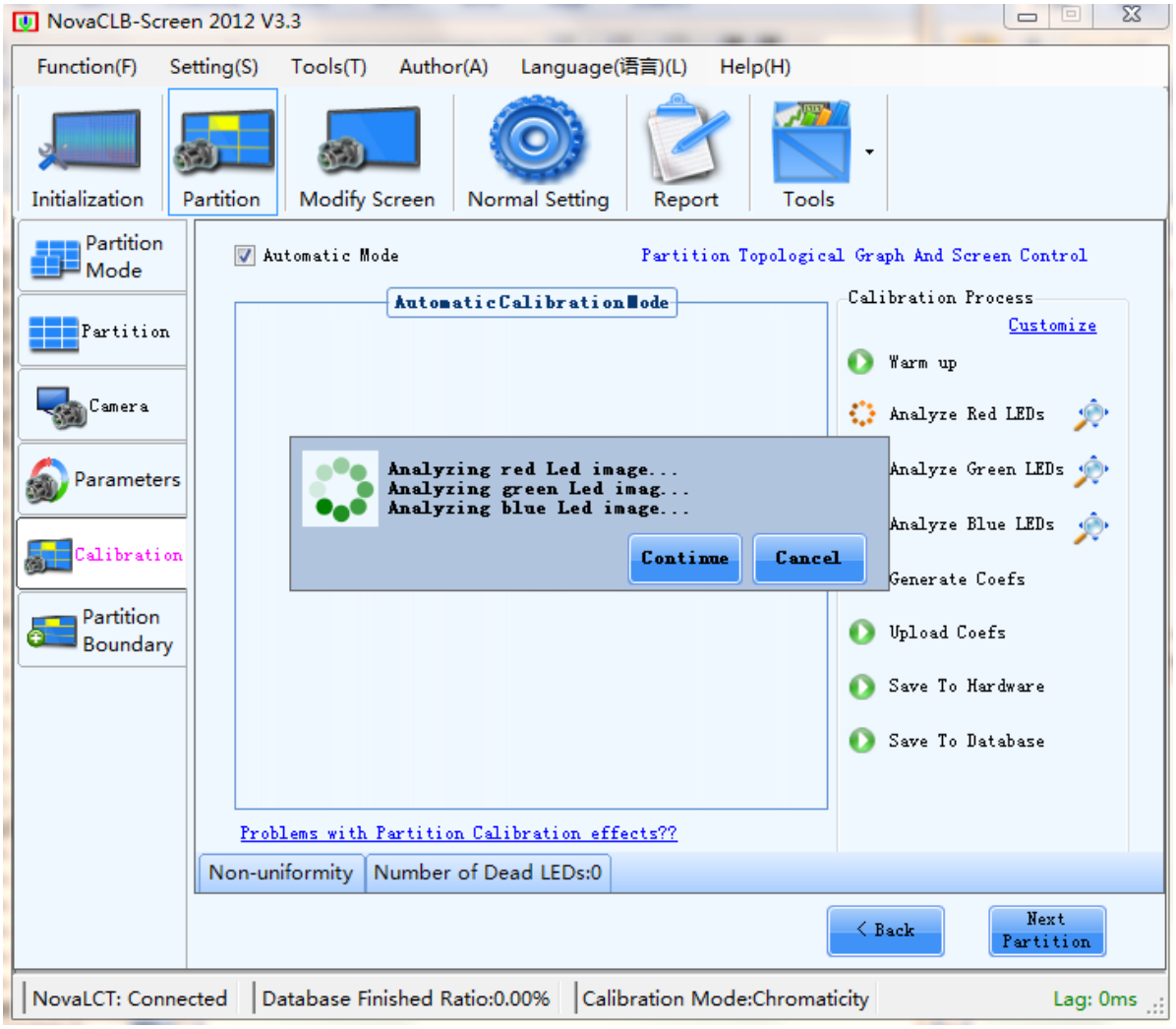


Fig. 3-39 Pause Calibration

Click "Next Partition" to enter into the next partition calibration, and one by one complete all partitions of the screen. When all finished, if still exist difference among these partitions, then start "Full-screen Calibration" to eliminate it.

3.3.5 Partition Boundary

When "partition operation" is conducted for the normal partition, if "Eliminate the boundaries" is ticked and there are more than two partitions, it will enter the interface of "Partition Boundary" after completion of calibration.

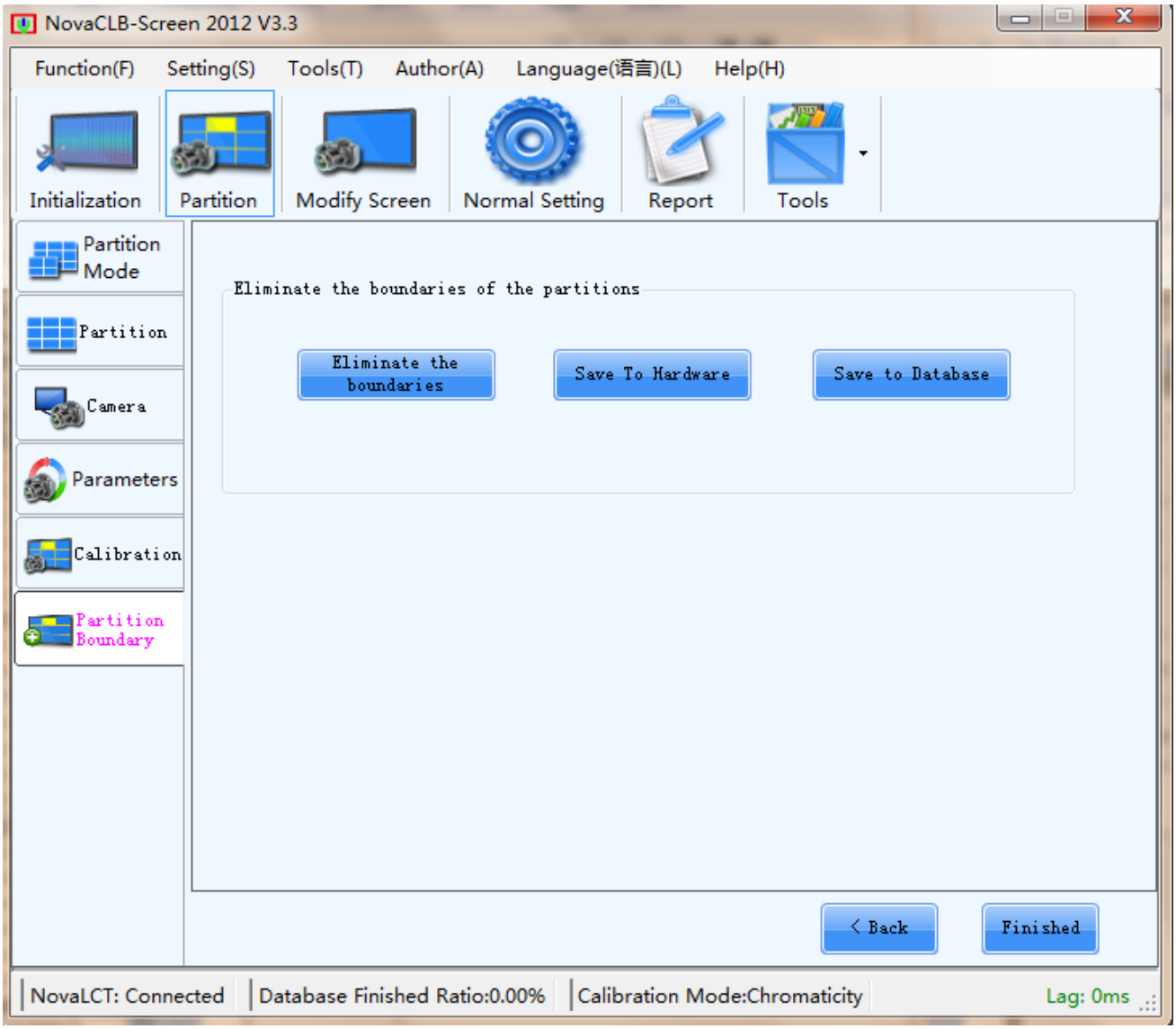


Fig.3-40 Partition Boundary

Eliminate the boundaries: To eliminate the boundaries of all present partitions.

Save To Hardware: Coefficients of partition calibration are saved to hardware, they will not be lost in case of blackout.

Save to Database: Coefficients of partition calibration will be saved to database.

3.4 Modify screen

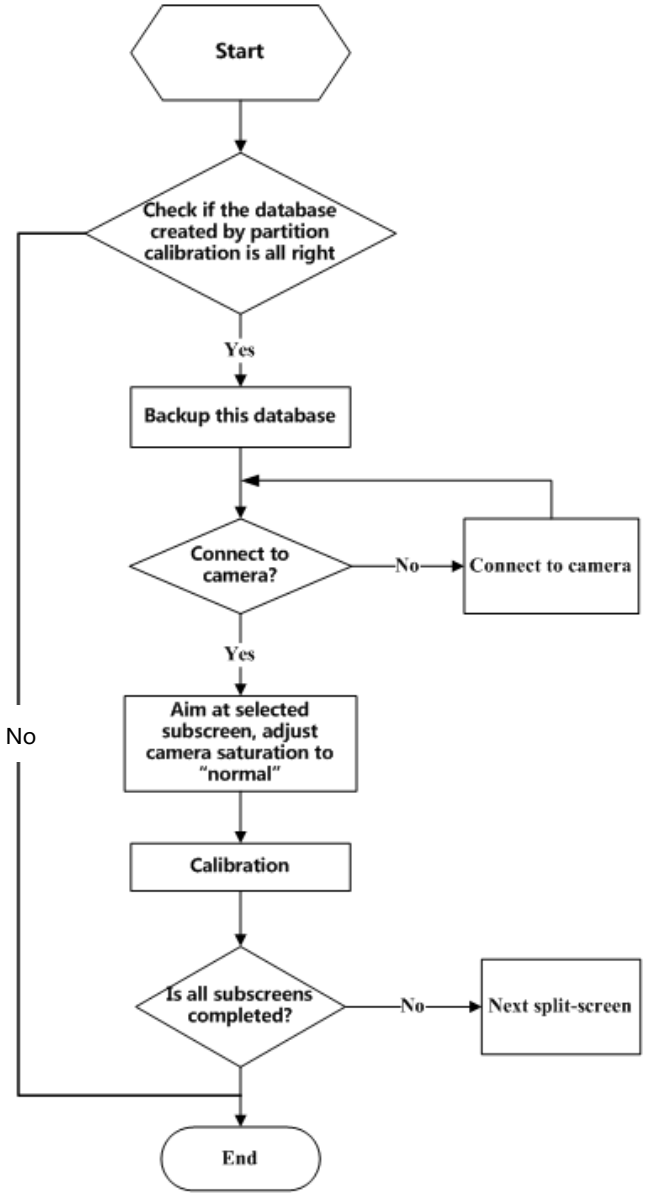


Fig.3-41 Modify screen Calibration Flow Diagram

Full-screen calibration is used to eliminating the differences among partitions, improve uniformity of the display screen. But users must notice that the precondition is the database created by Partition calibration must be all saved.

3.4.1 Sub Screen

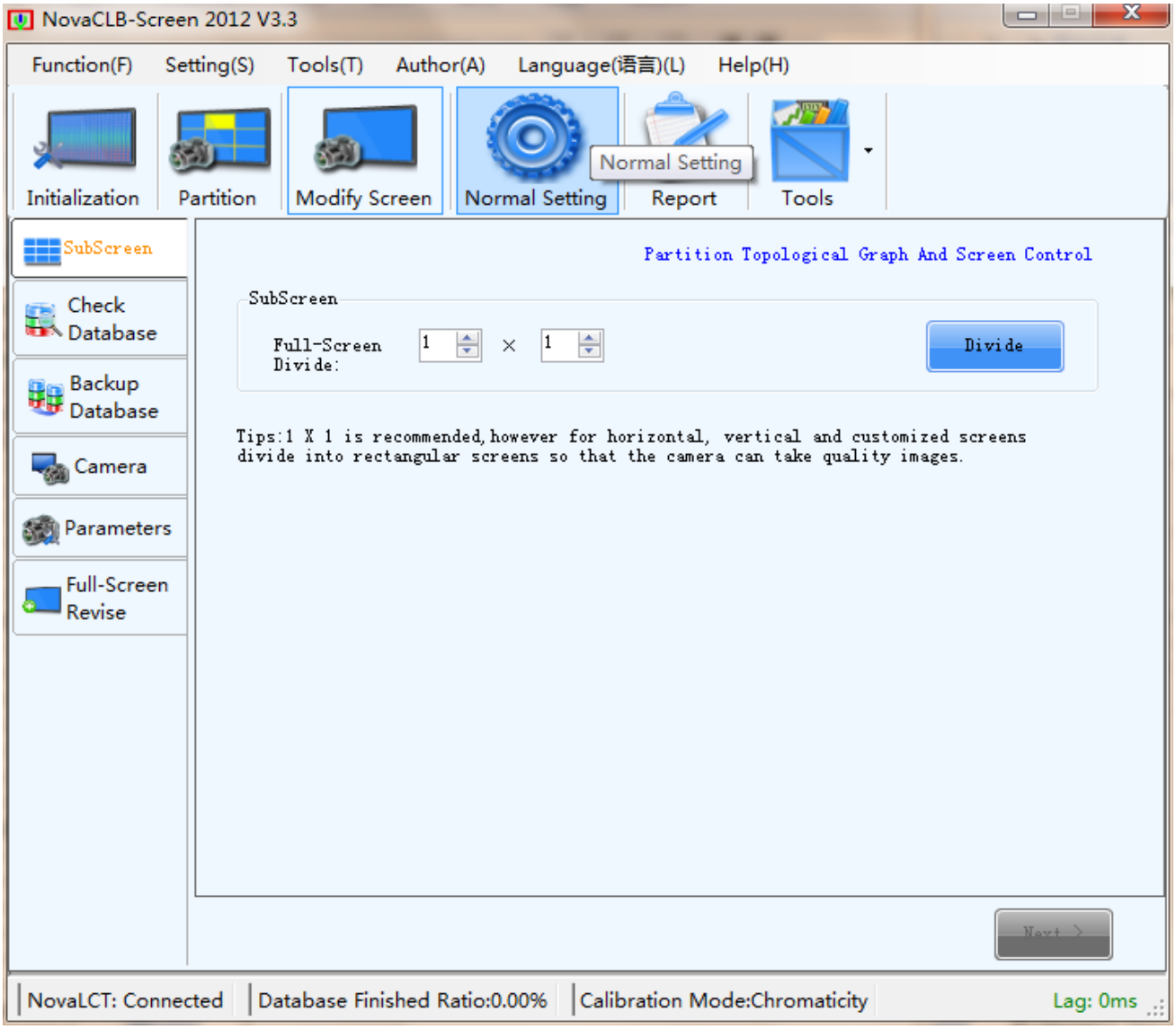


Fig.3-42 Sub screen

✧ **Sub screen**

Divide display screen into several sub screens, it' s size is generally recommended 1*1, if the screen is vertical strip or horizontal strip, you may set 2*1 or 1*2 to let camera obtain more clear images.

3.4.2 Check The Database

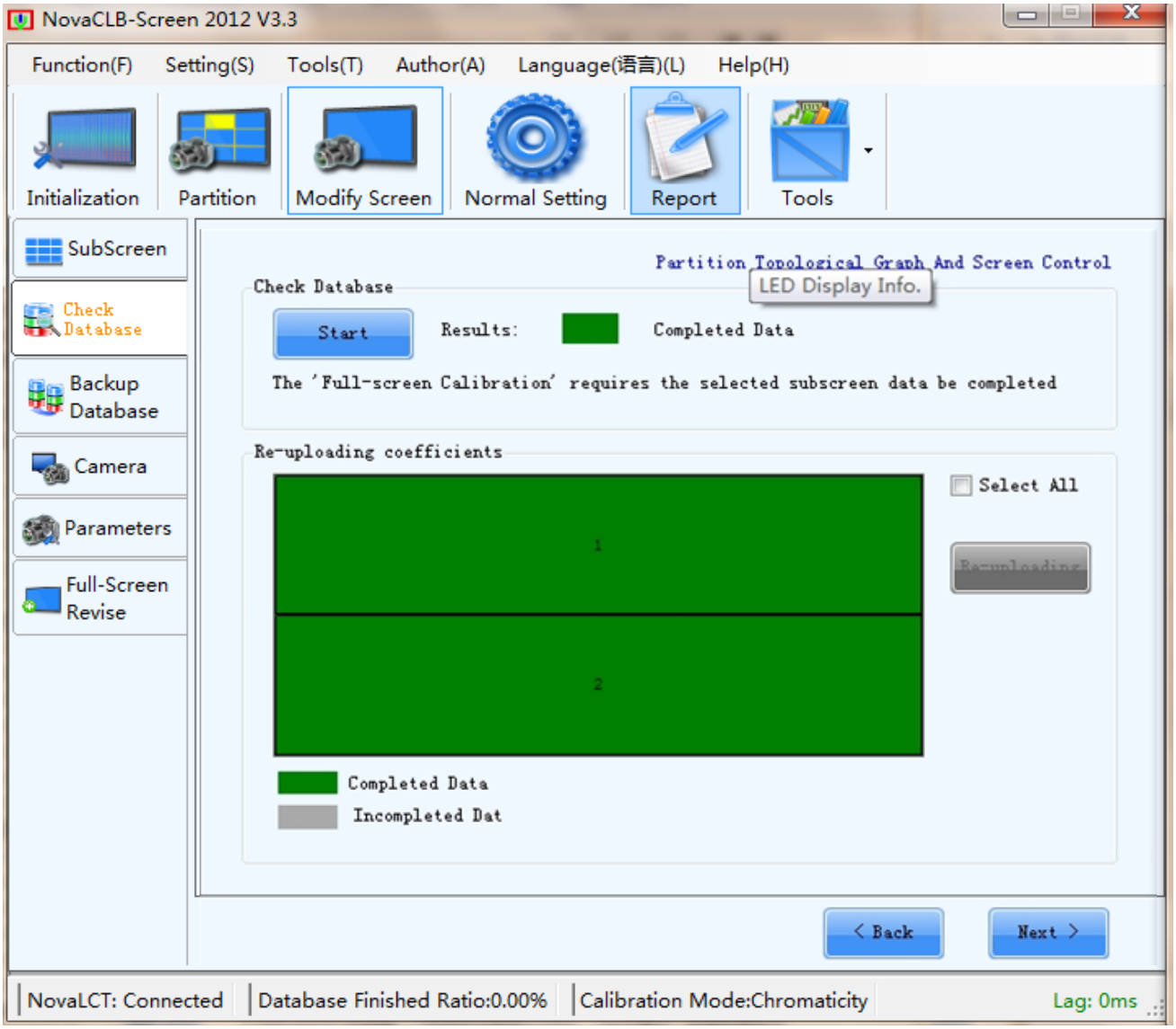


Fig.3-43 New Revise Database

✧ Check The Database

The software will check if the database is all right, check results will show in the white rectangular, the green stands for yes while gray stands for no. To the screen whose database is all right, click "Re-Uploading".

If the screen calibration coefficient has already been not in conformity with the database, it is required to click “Select All”, and re-upload.

Only whose database is all right can do full-screen calibration. After check, click "Next" to enter

into "Backup Database".

3.4.3 New Revise Database

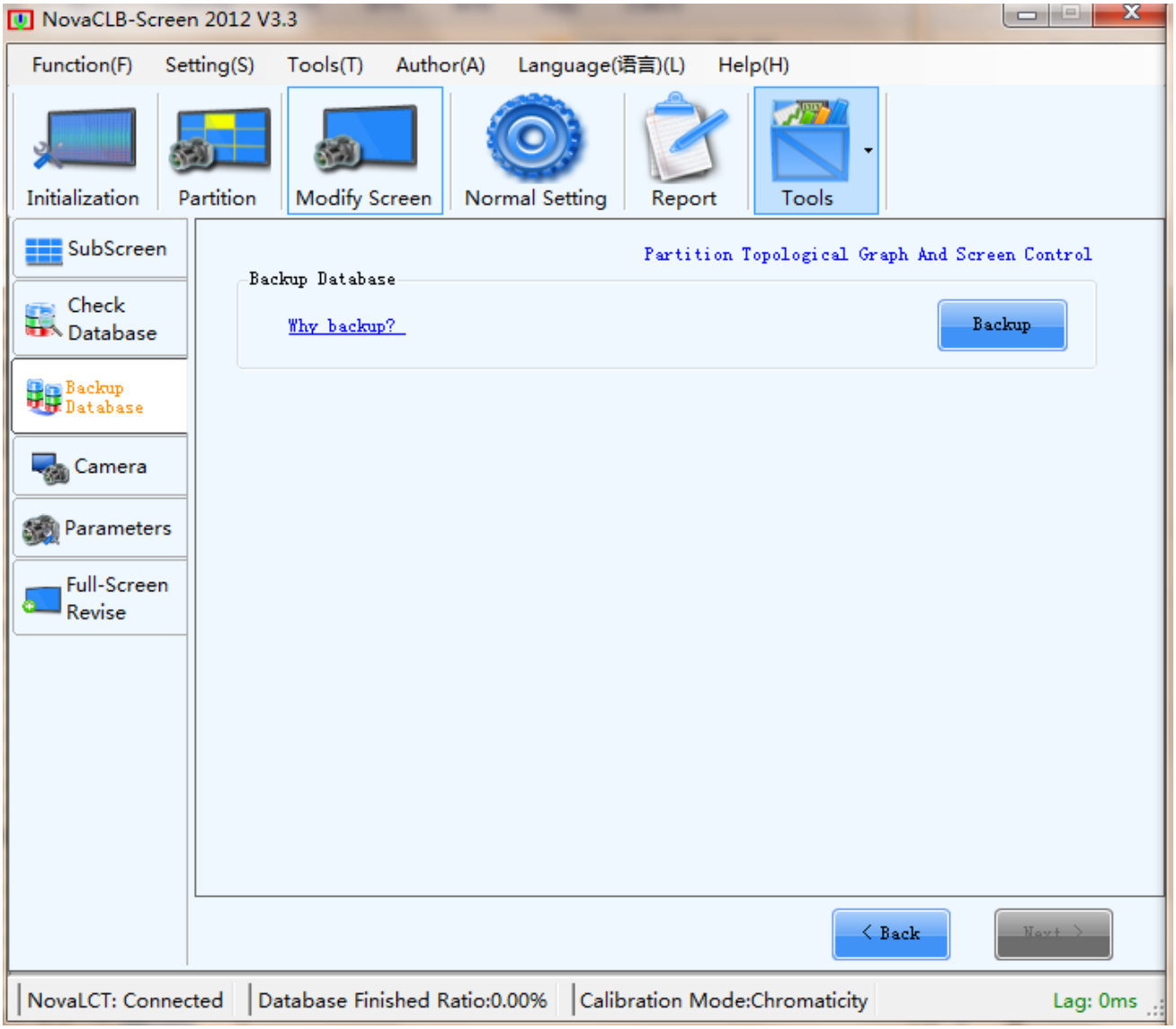


Fig.3-44 Backup Database

✧ Backup Database

Full-screen calibration may update coefficients in the database, thus we need to backup database to guarantee the original calibration coefficients unbroken. When you backup the database you'd better indicate that it is created by Partition calibration to prevent confusion. The backup database should be properly kept, when full-screen calibration failed affected by

the surroundings, you can use the backup database to do full-screen calibration again.

When completed, click "Next", enter into "Connect to camera".

3.4.4 Connect To Camera

The same as 3.3.2.

3.4.5 Camera Parameters

The same as 3.3.3, what should users notice is, when doing full-screen calibration, the camera imaging doesn’ t have to be clear, adjust it a little fuzzy will be better.

3.4.6 Full-screen Revise

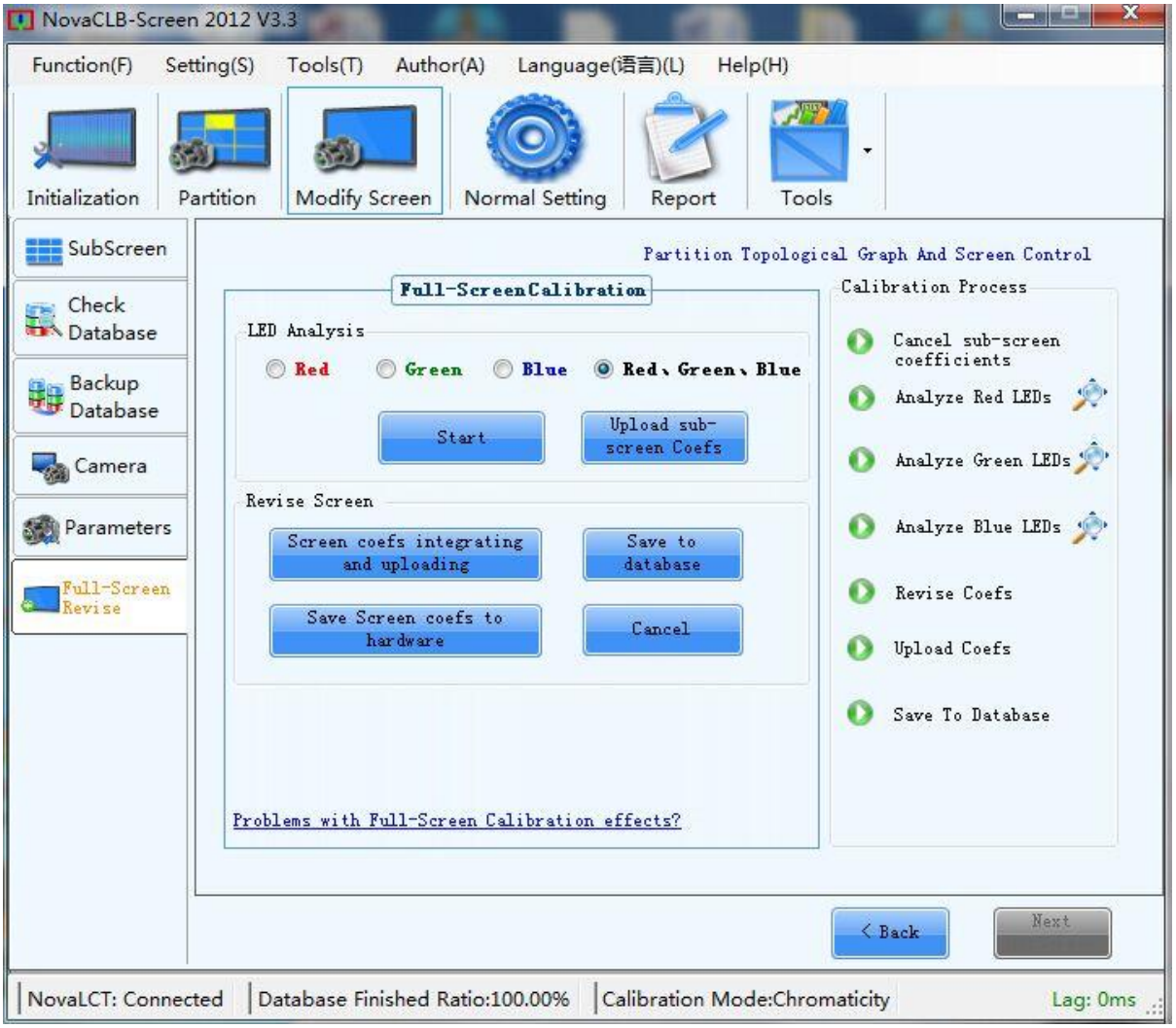


Fig.3-45 Page Of Full-screen Revise

✧ Full-screen Revise

Be sure to aim the camera lens at the selected sub-screen, and then click "Start" to automatically fulfill such functions as "Cancel sub-screen coefficients" and "Analyze Red, green, blue LED". "Cancel sub-screen coefficients" is to cancel the coefficients that are not saved, and "Analyze Red, green, blue LED" requires partition effect;

then the software will do the following things automatically: Control screen display colors, manage camera gain pictures and analysis intelligently. And the corresponding process can be seen on the right of the page.

If the sub-screen effect is good, click "Upload sub-screen Coefs" to automatically fulfill such functions as "Revise Coefs", "Upload Coefs" and "Save to Database".

Make calibration for the sub-screens one by one. After the calibration, please keep the calibration database with due care; when calibration to all sub-screens is completed, click "screen coefficients integrating and uploading" to upload the screen coefficients; if the full-screen calibration effect is good, click "save full-screen coefficients" and "save to database".

So far, that's all for all calibrations.

Attention: please be sure to confirm the full-screen calibration effect before save to database, or partition database shall be loaded to do full-screen calibration again.

4 Module Calibration

There are two modes for the replaced module, one is off-line mode, while another is connecting with LCT for online calibration.

It is required to read the average calibration coefficient of the area to be calibrated when conducting calibration to the module under off-line mode, and this coefficient shall be acquired

from LCT; after completion of module calibration, the calibration coefficient will be uploaded to the screen through LCT.

The calibration procedure of the off-line mode is basically the same as connecting to LCT mode, which shall be stated together below, and the difference of part of the interface shall be paid attention to.

4.1 Initialization

Start the software, directly enter the calibration mode sub-interface of calibration initialization, Choose "New module" of calibration mode, and click "Next", and enter the network setting interface.

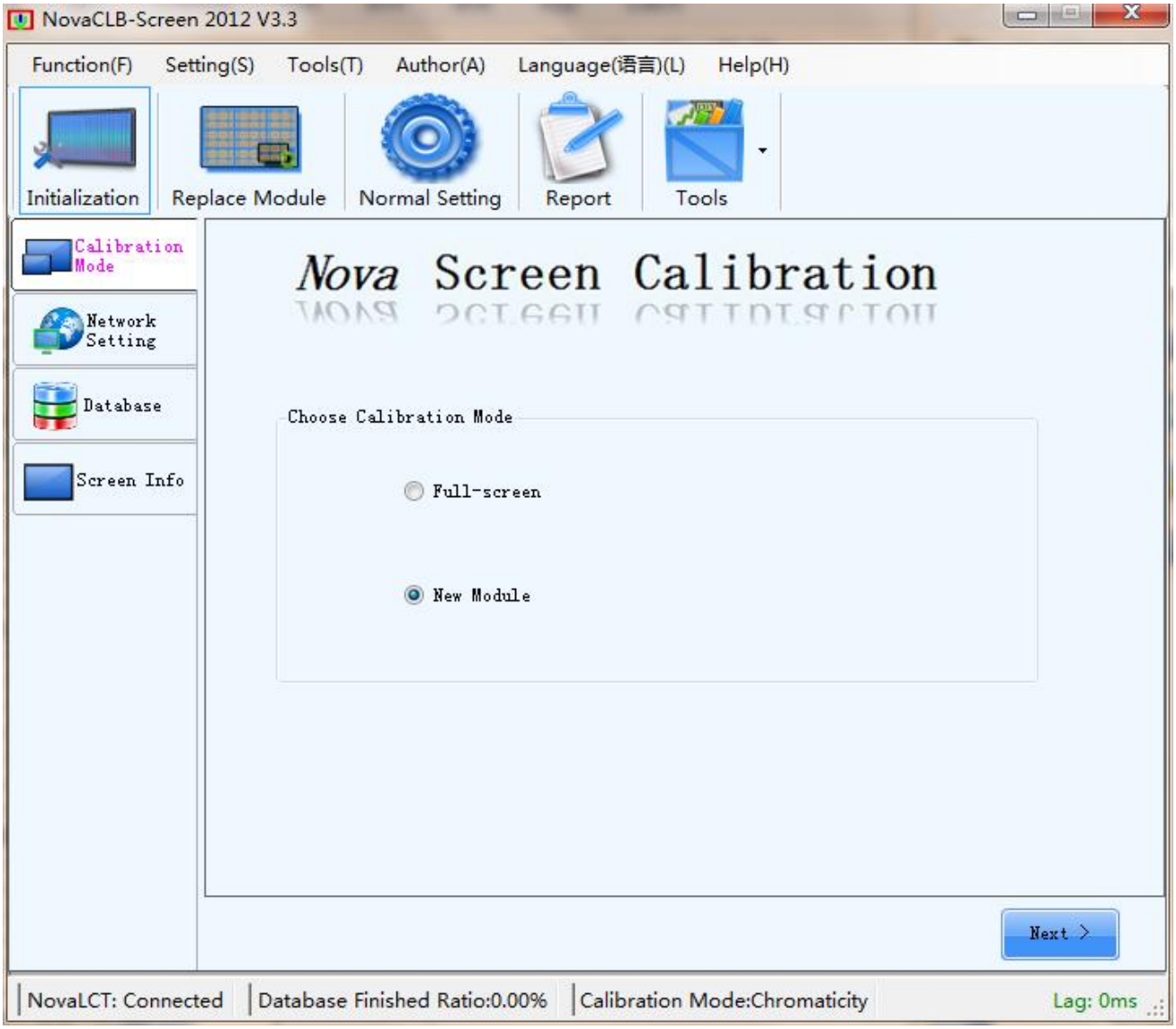


Fig.4-1 Choose Calibration mode

4.1.1 Network setting

1) Connect to LCT for online calibration

Open the page frame of screen calibration on NovaLCT, then conduct network setting on NovaCLB-Screen, where the IP and port are the same with that of the machine of NovalLCT, and after completing, click "Connect".

After connecting successfully, NovaCLB-Screen automatically acquires the screen number and pixels, and the number of the screen to be calibrated shall be selected.

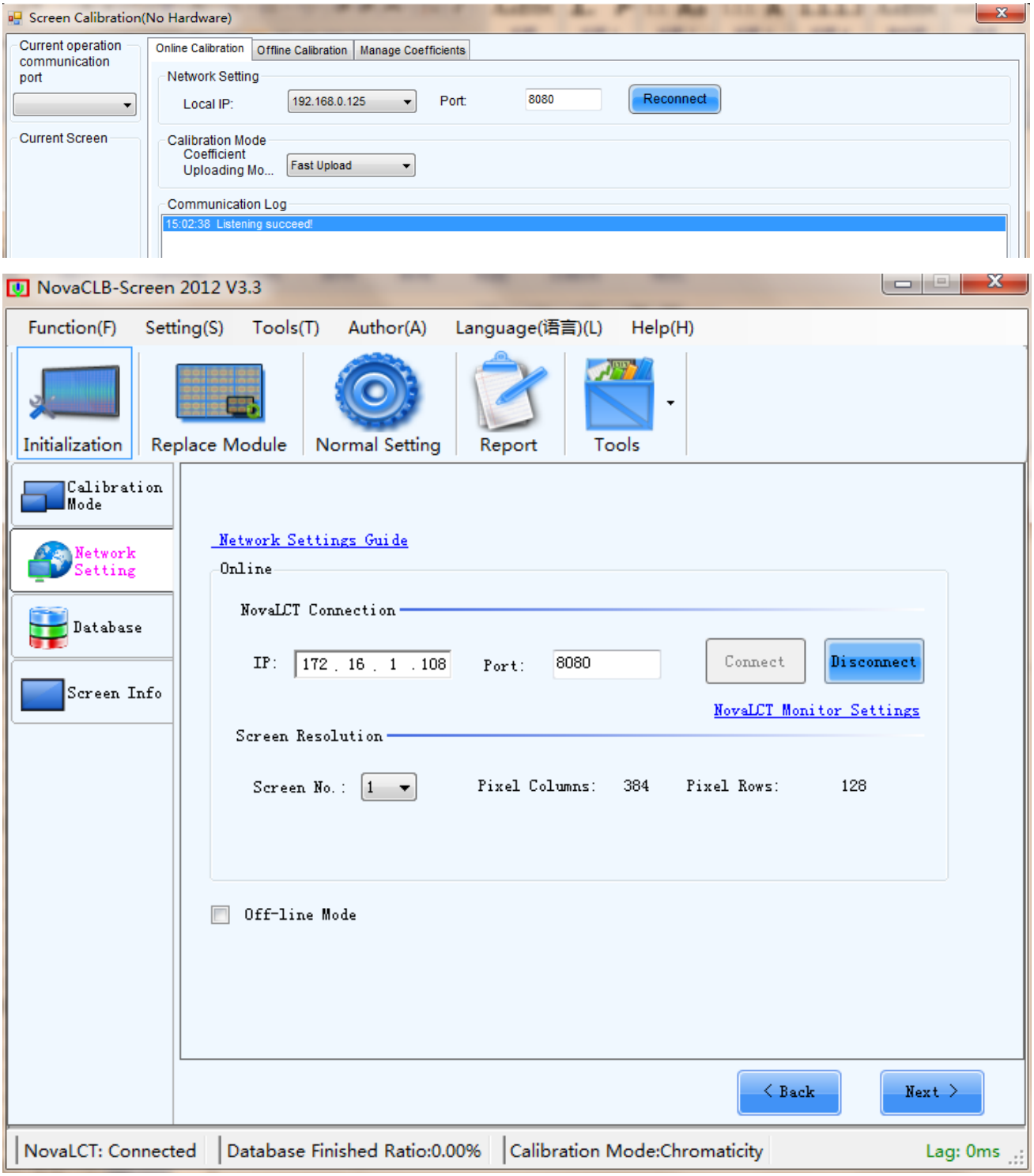


Fig.4-2 Network setting(on-line mode)

2) Off-line mode

Tick "Off-line mode", and click "Next".

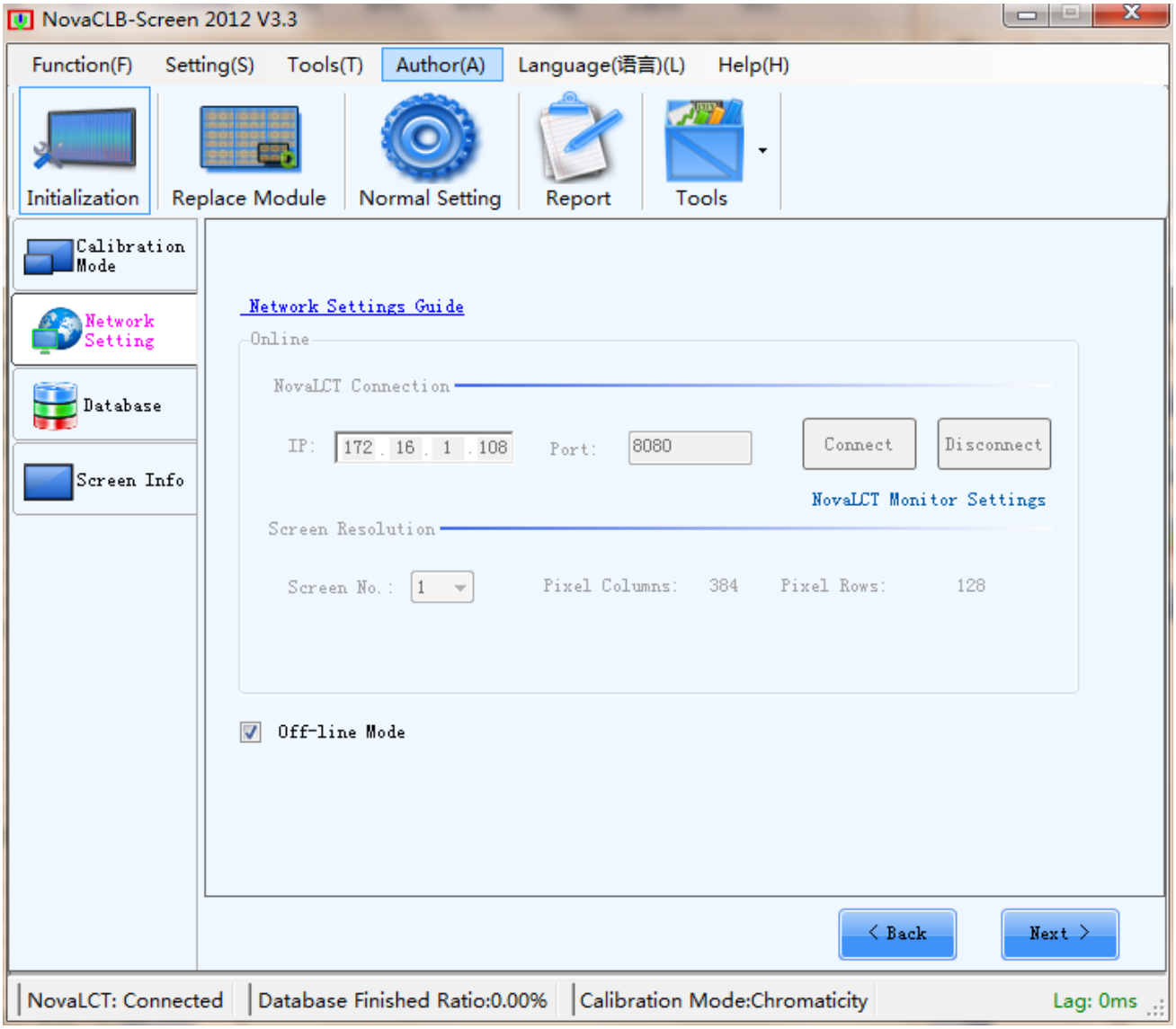


Fig.4-3 Network setting(off-line mode)

4.1.2 Database

New database or the existing database can be used, and the database is for saving the calibration coefficient of the screen.

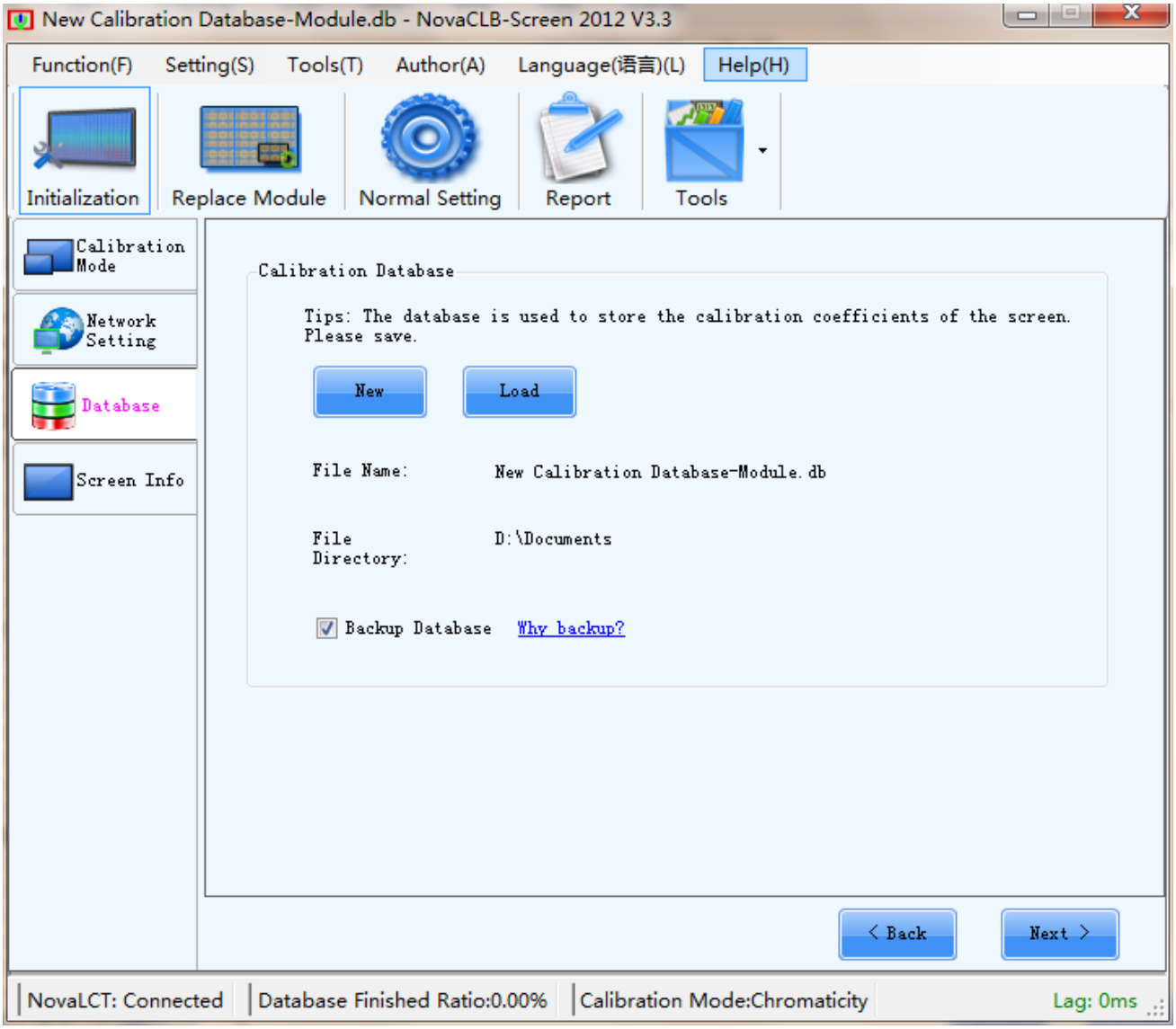


Fig.4-4 Database

4.1.3 Screen Info

Fill the screen information based on actual situation, refer to 3.2.4 Screen Information in the Chapter of full-screen calibration for details. Click "Next" after completion to enter the subpage of "Module position" in "Module replacement".

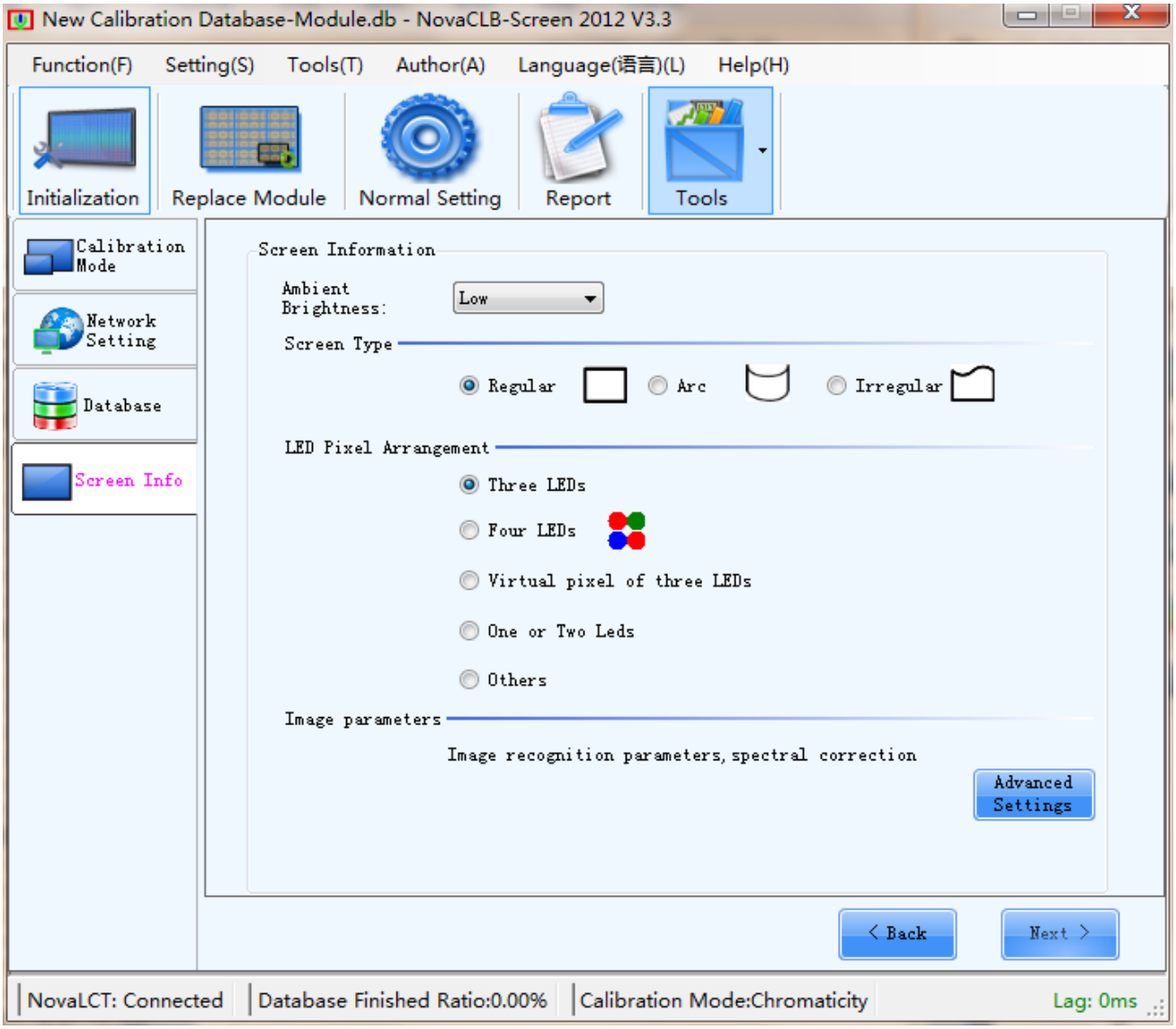


Fig.4-5 Screen information

4.2 **Module**

Procedures for module replacement is: module Location→ camera connection → camera parameters→ module calibration.

For these procedures, the procedures of online calibration connected with LCT and off-line mode have some differences in module position and module calibration.

4.2.1 Module location

The position of the new module shall be located accurately so as to perform accurate calibration

for the new module.

4.2.1.1 Online calibration（Connect to LCT）

1) Manual setting

If the calibration personnel knows clearly about the coordinate position of the new module, manual setting can be used to quickly set the coordinate and the module size, and click "Next" to connect to the camera.

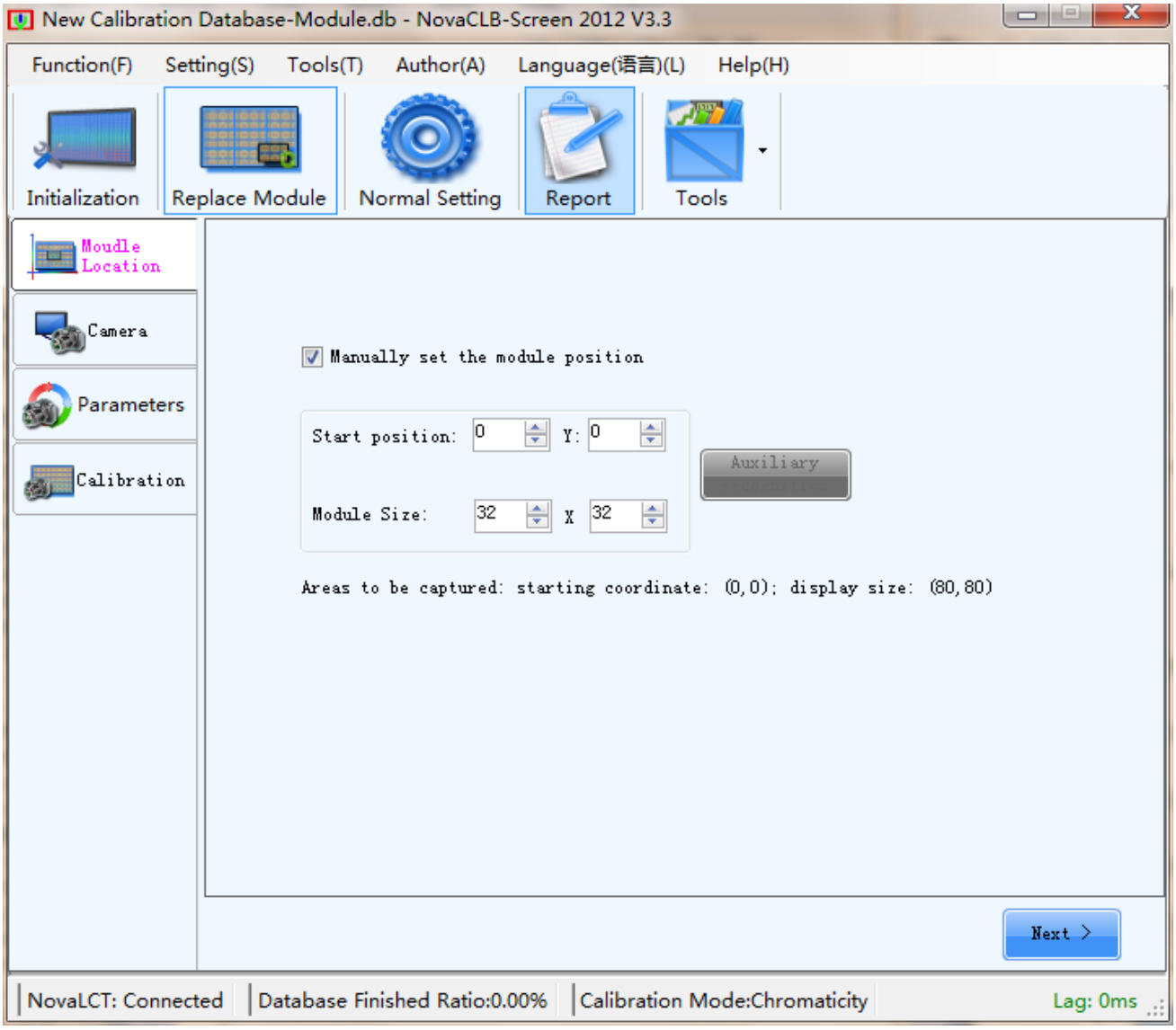


Fig.4-6 Manually set the module position

2) Auxiliary recognition

If the position of the new module cannot be located accurately, click "Auxiliary recognition"; and the following steps are as follows:

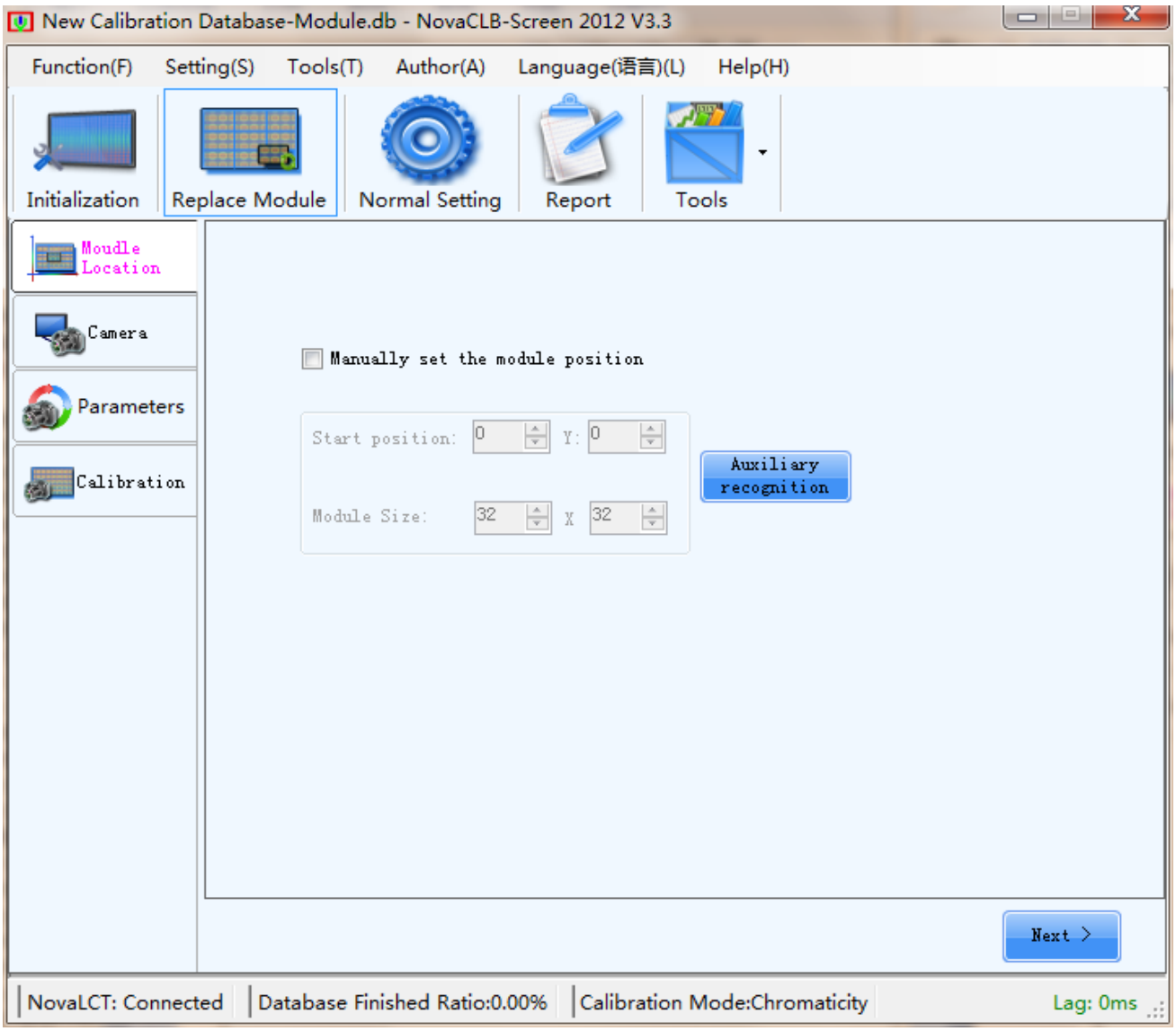


Fig.4-7 Auxiliary recognition

a) Set the module size, click "Next", and it can be seen that the screen is divided into multiple partitions with numbers (the software defaults to conduct partition as every partition has 4×4 modules).

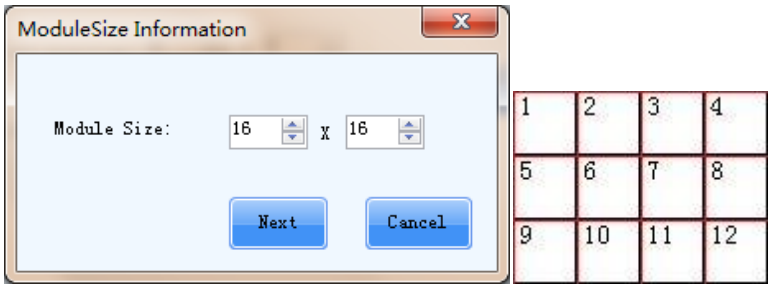


Fig.4-8 Module Size information

b) Select number of the area where the new module is, then click "Next", and the screen displays the partition separately as well as the module number.

User can click "Reset the area size" to reset the amount of the module in every area, as shown in the following figure; after setting, click "Reposition", and click "OK", and the screen will display the area division after repositioning.

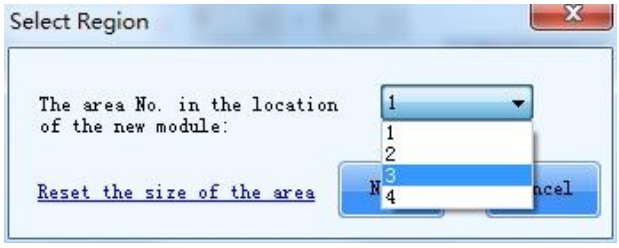


Fig.4-9 Select Region

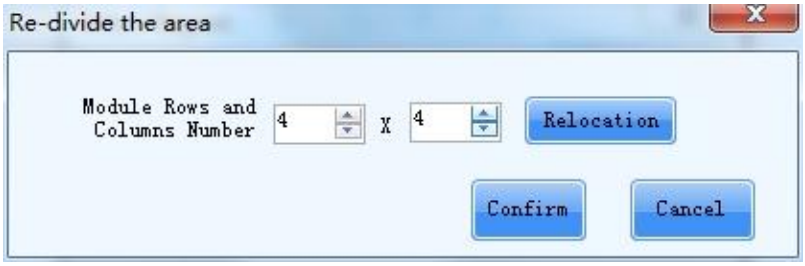


Fig.4-10 Re-divide the area

c) Confirm the number of the new module, and click "OK".

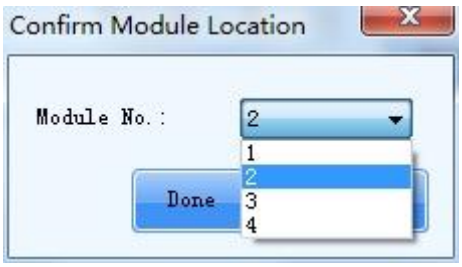


Fig.4-11 Confirm Module location

4.2.1.2 Offline Calibration

Set pixel columns and rows of the screen, starting coordinate of the new module, and module size.

Click "Next".

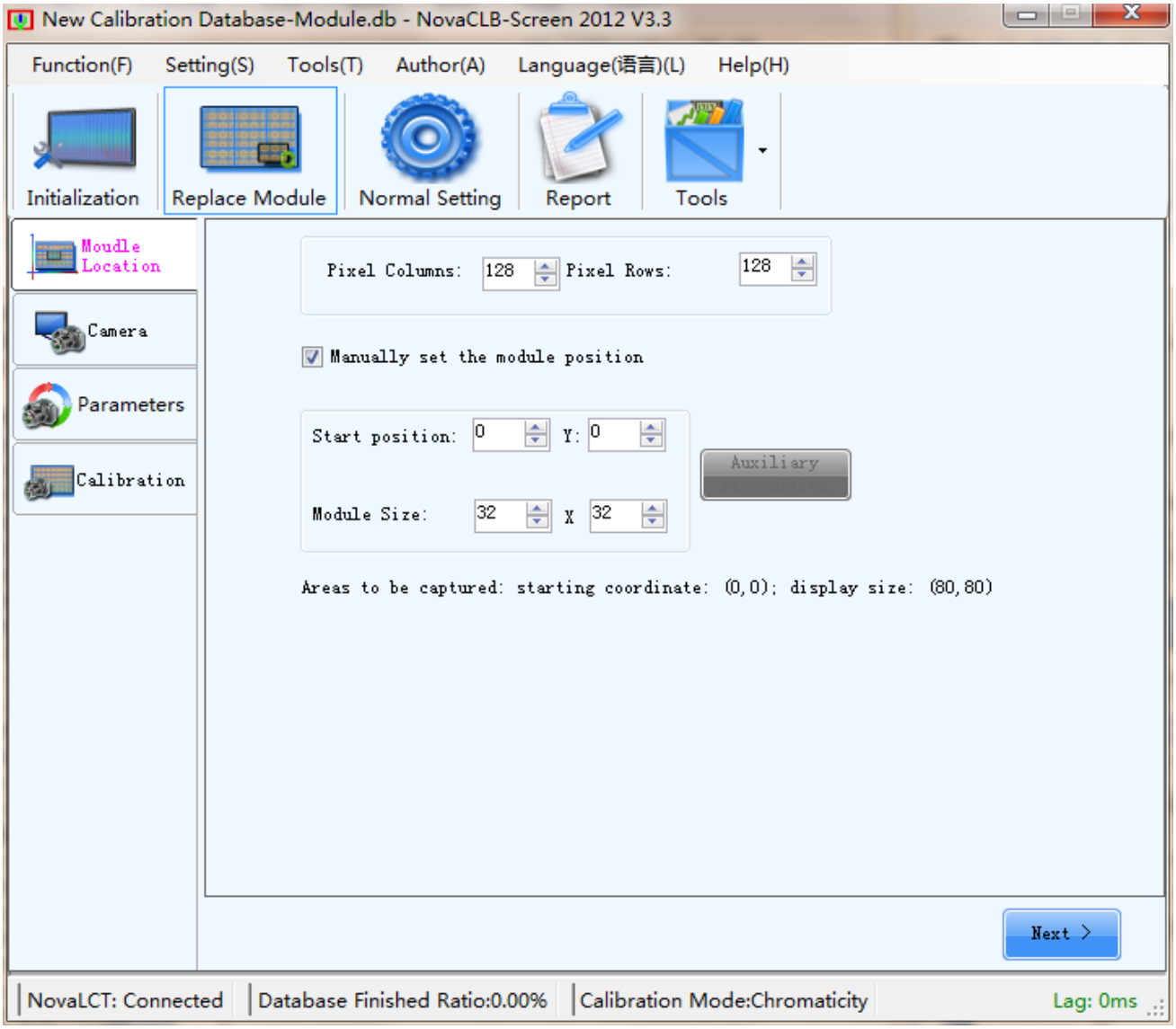


Fig.4-12 Module location(off-line)

4.2.2 Connect to Camera

During calibration, the camera must be connected to the calibration computer normally, kept as aligning to partition and can photograph normally. If the camera is connected successfully, the state of the camera is shown as follows, click "Next" to enter camera setting.

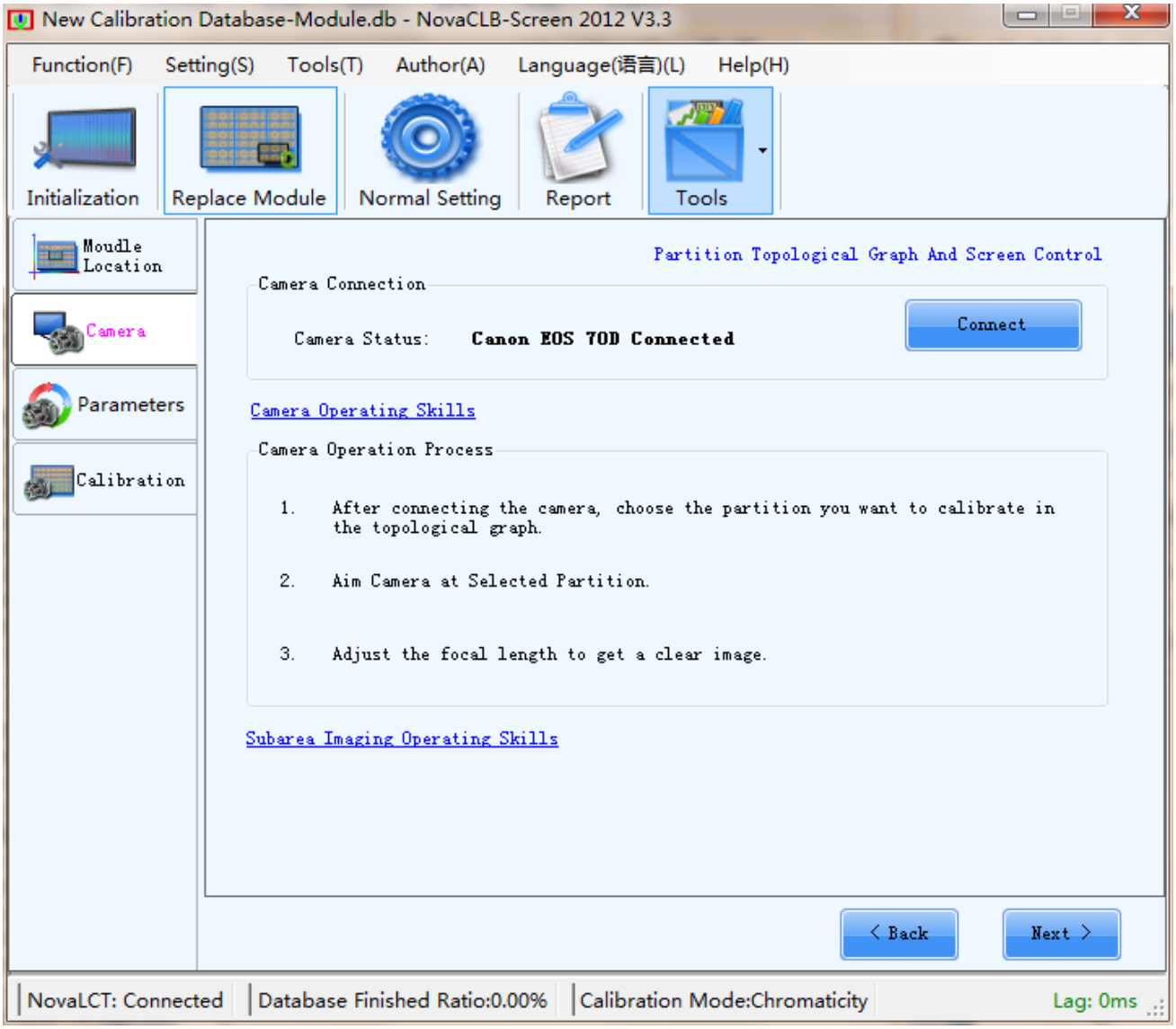


Fig.4-13 Connect to Camera

4.2.3 Camera Parameters

No matter manual or automatic adjustment is used, adjust the saturation of the camera to be normal, refer to 3.3.3 Camera parameters for details.

After completing setting, click "Next".

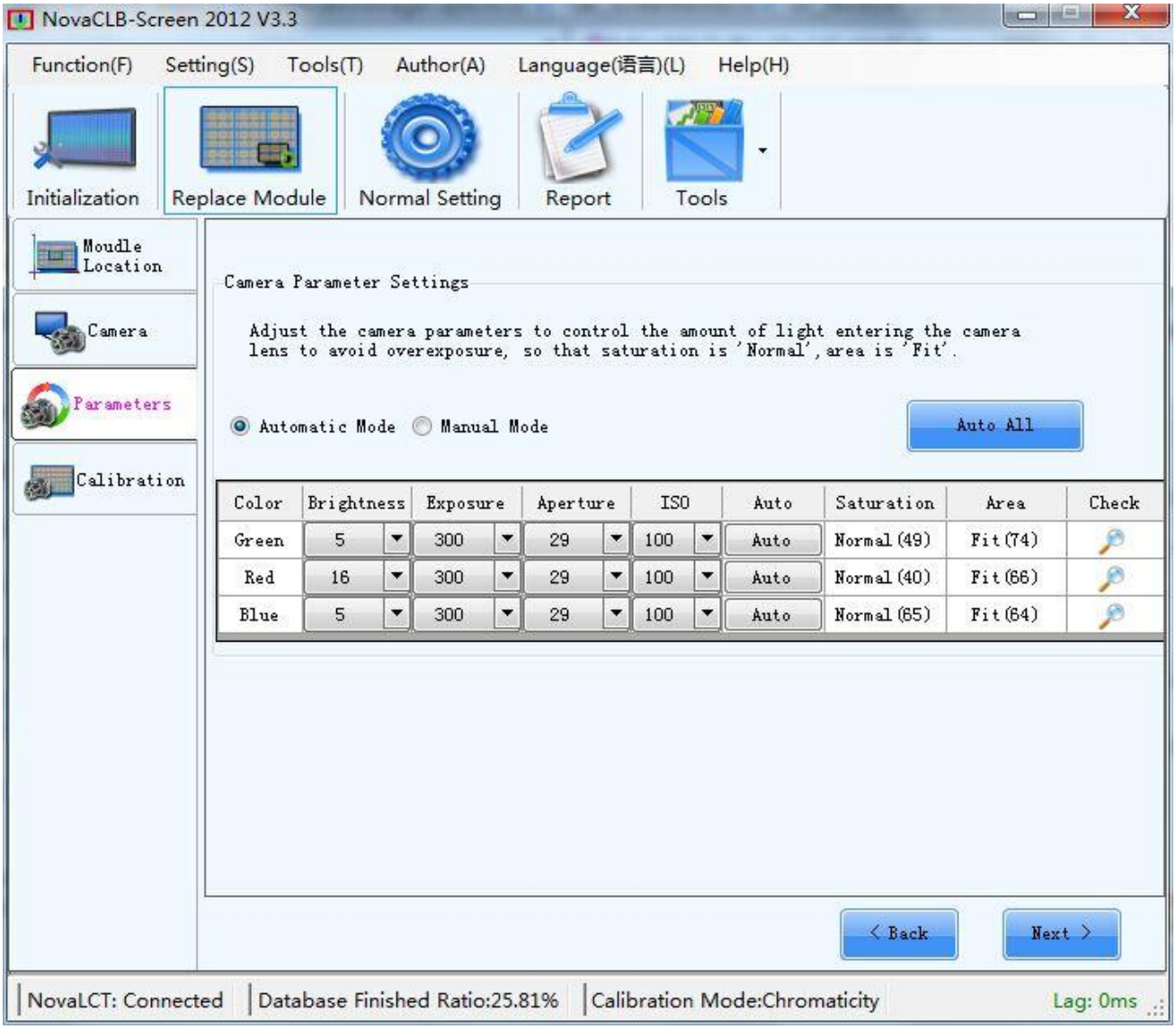


Fig.4-14 Camera Parameter Settings

4.2.4 Module calibration

4.2.4.1 Online calibration （Connect to LCT）

The software defaults to tick "Automatic mode" and click "Enable automatic calibration", and the software will finish the calibration to the module automatically.

User can cancel ticking "Automatic mode", and manually complete the module calibration according to the calibration procedures on the right.

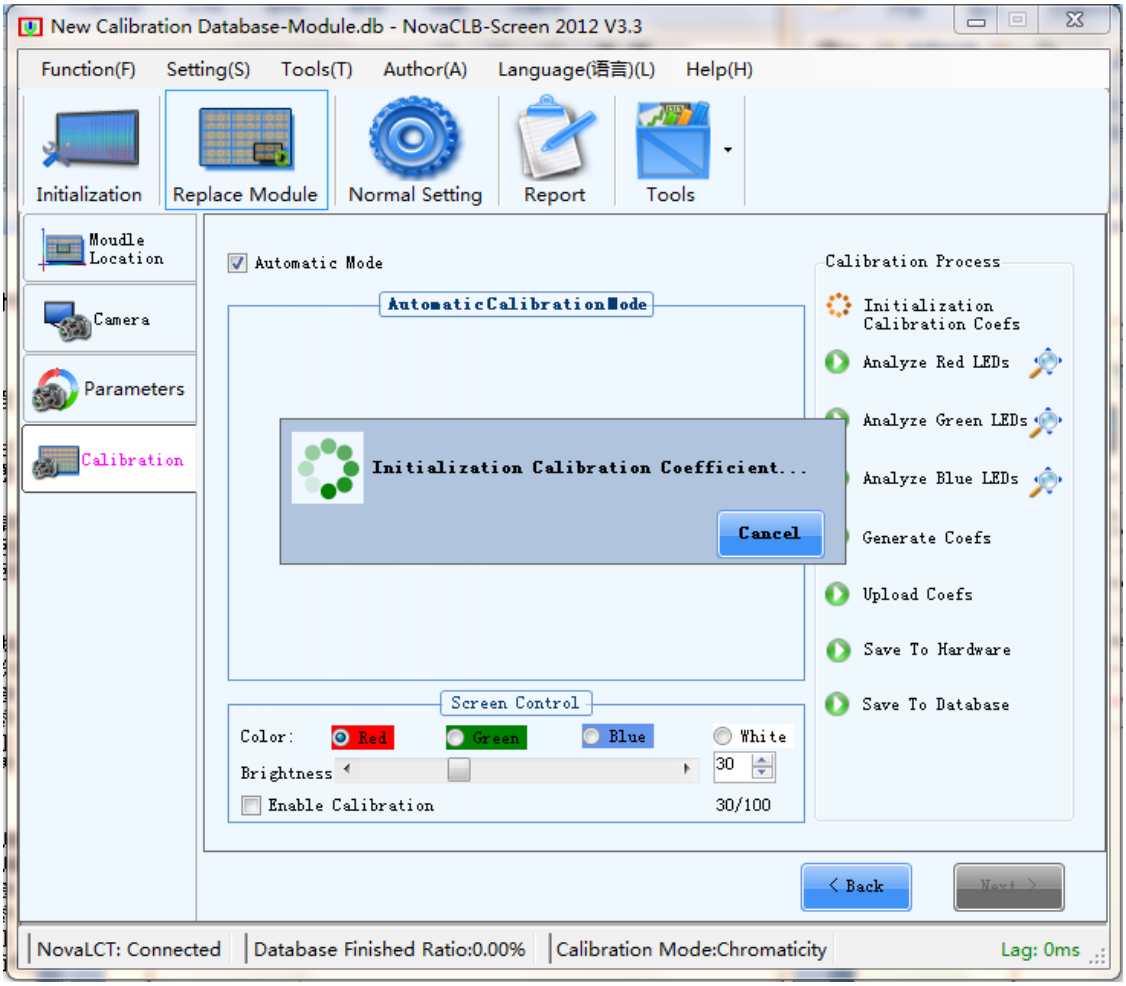
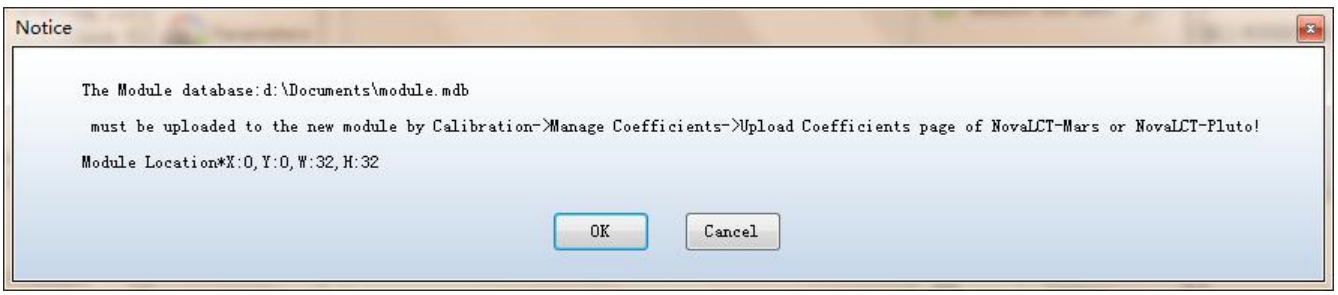


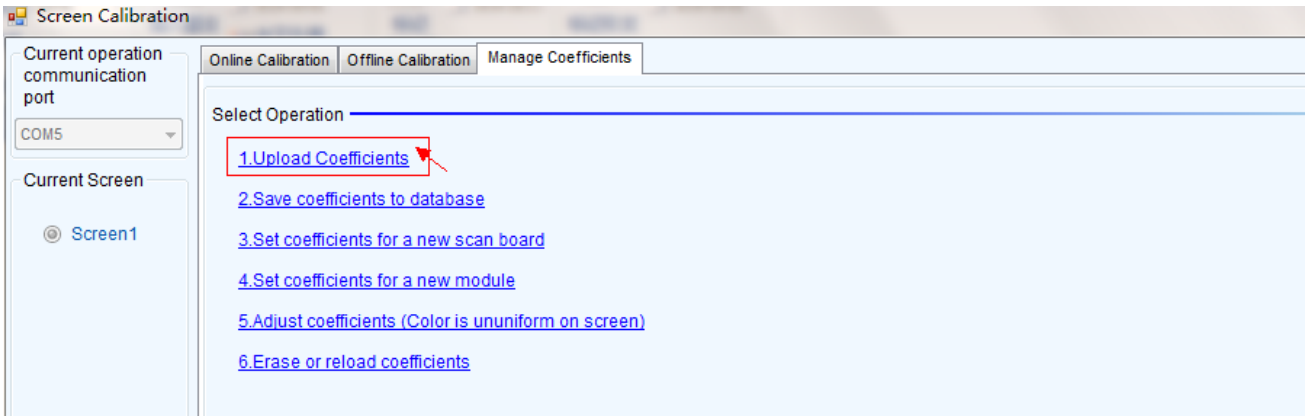
Fig.4-15 Module calibration (online calibration)

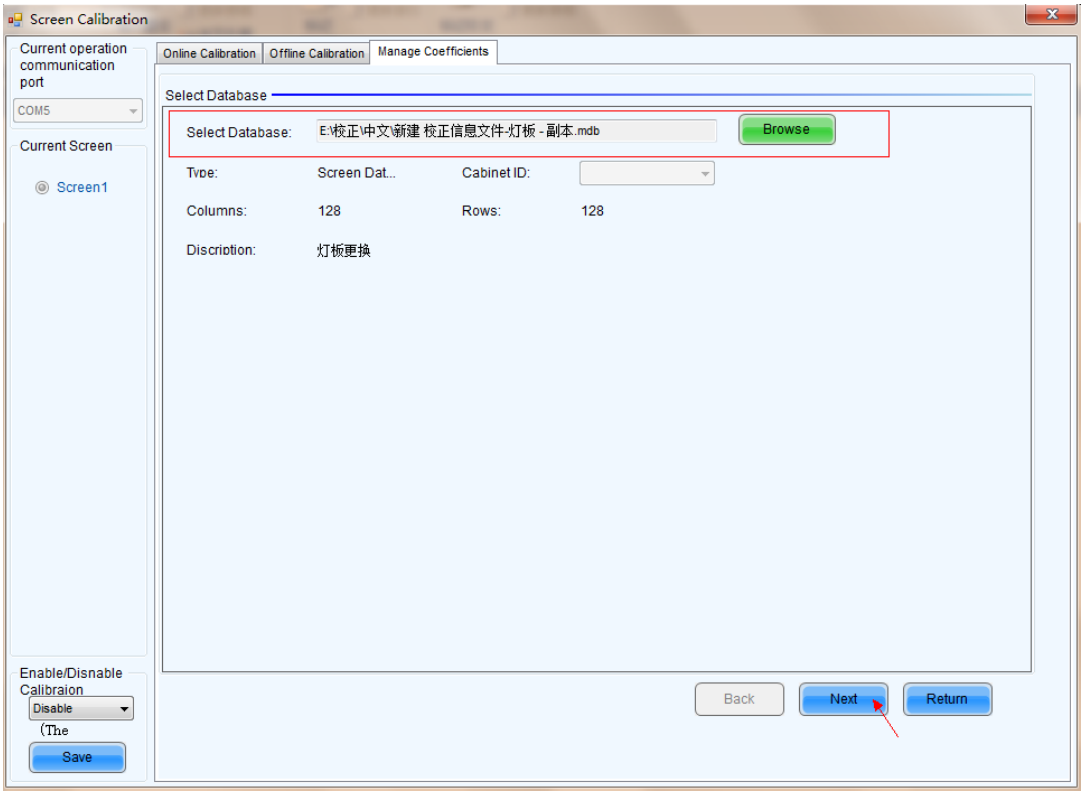
4.2.4.2 **Off-line mode**

When you start calibration under the offline mode, some dialog would be shown. Please read the tips on them carefully, and follow the tips to do certain operation, or the offline calibration cannot finish successfully.

1) Upload the module database to the new module







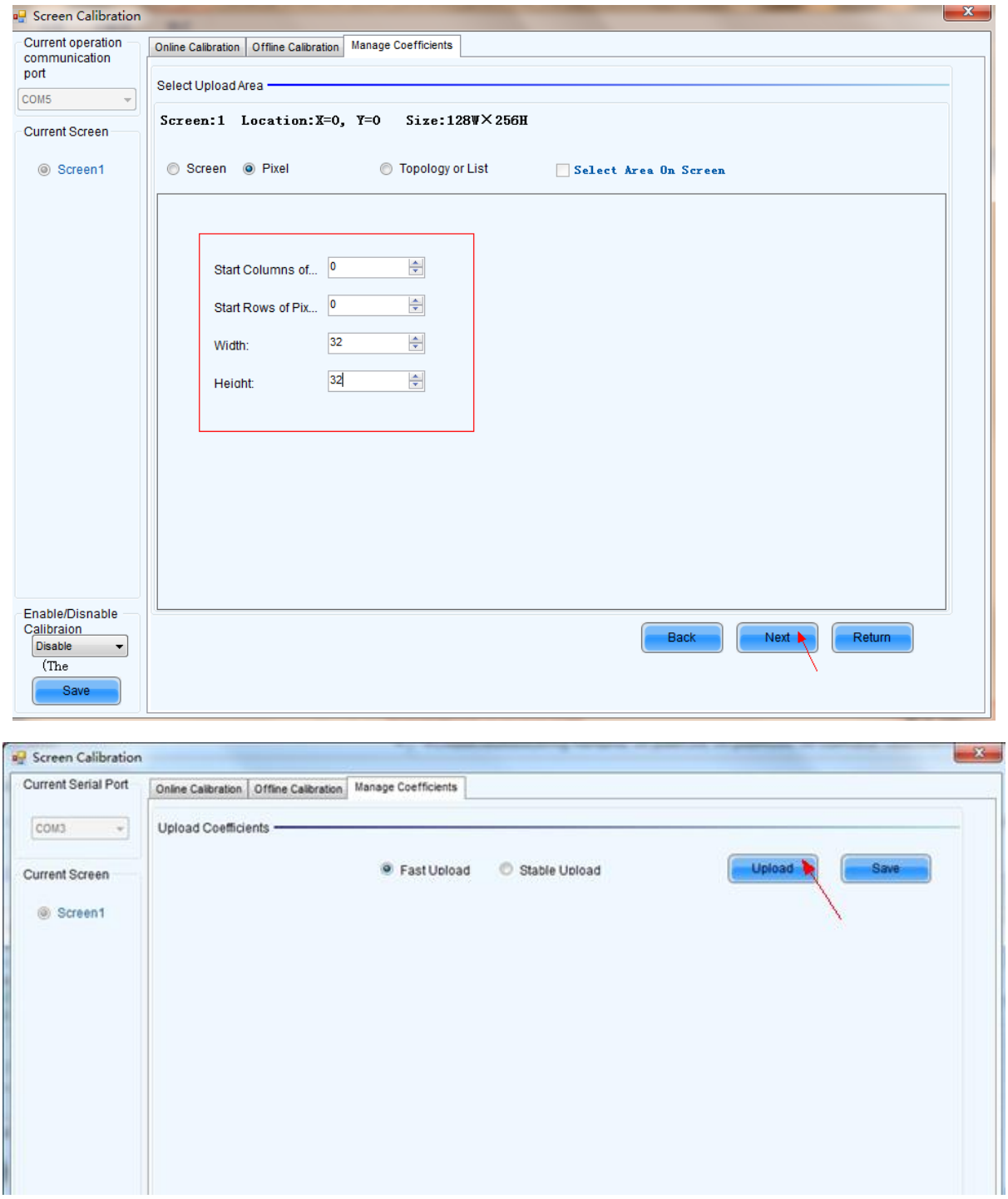


Fig.4-16 Offline calibration-Upload the module coefficient

2) Make sure the coefficients have been uploaded to new module, and then click ‘OK’.

Fig.4-17 Make sure the coefficients in the database

3) Get the average coefficient of calibration area on offline calibration interface of LCT and input them.

Respectively fill the coordinate, width and height (X, Y, W and H) of the new module area and the collecting area of the Fig. 4-18 into the display area of Fig. 4-19, and then click "Get average coefficient" to get the average coefficients of the new module area and the area to be collected.

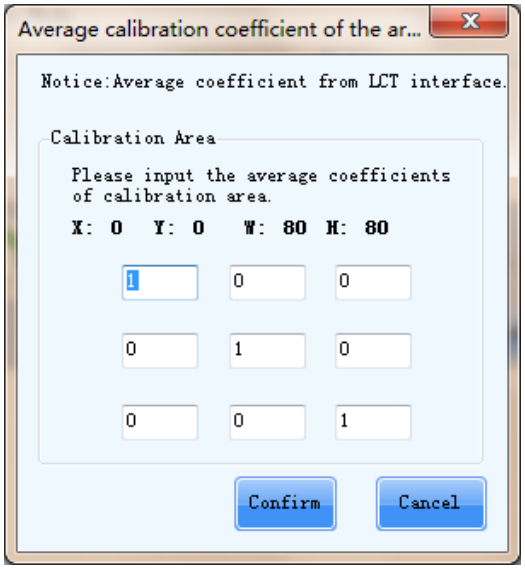


Fig.4-18 Average calibration coefficient of the area

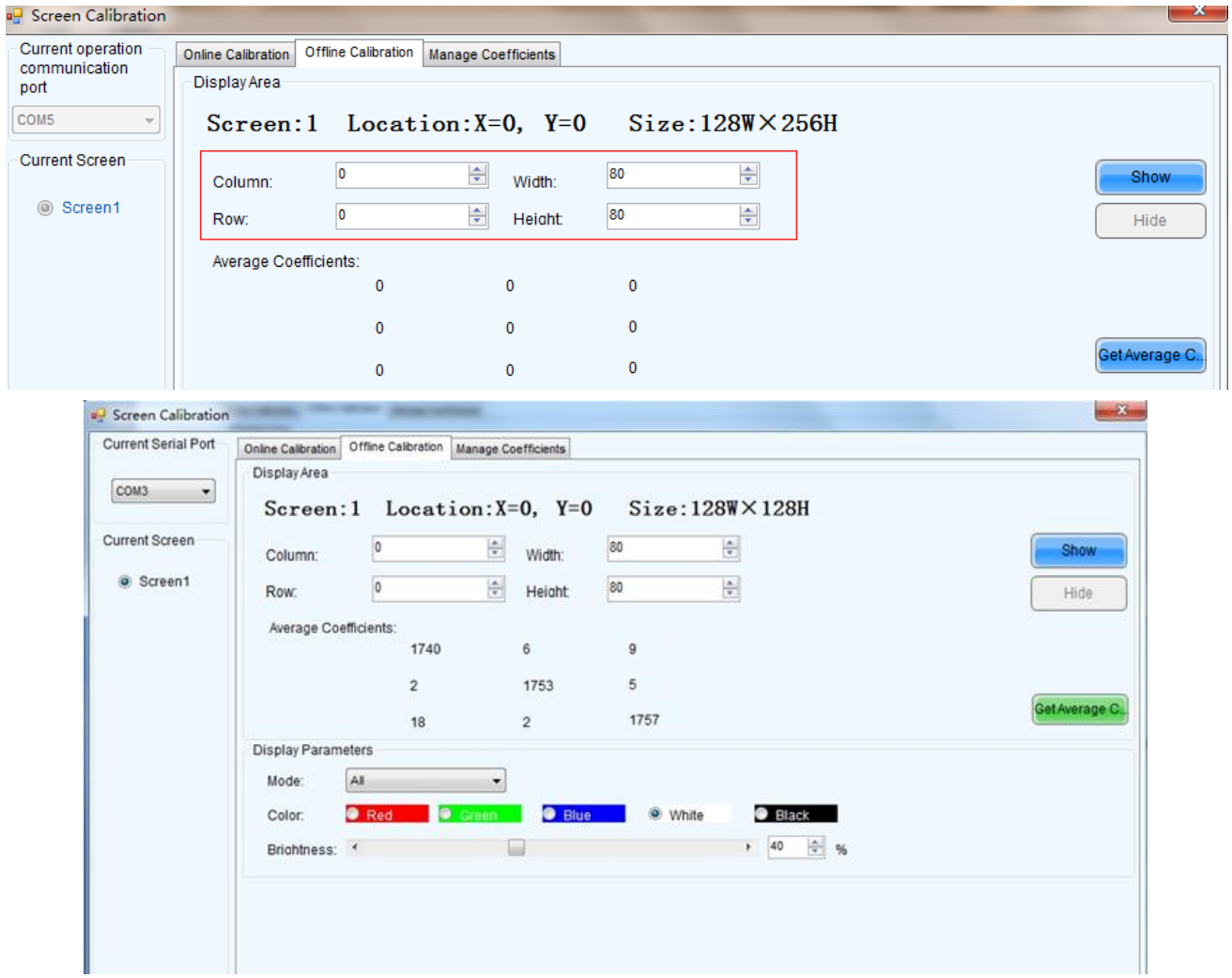


Fig.4-19 Offline-Get Average coefficient

4) Input the average coefficient of the collecting area at the average coefficient to be calibrated window of NovaCLB-Screen (as shown in Fig. 4-18).

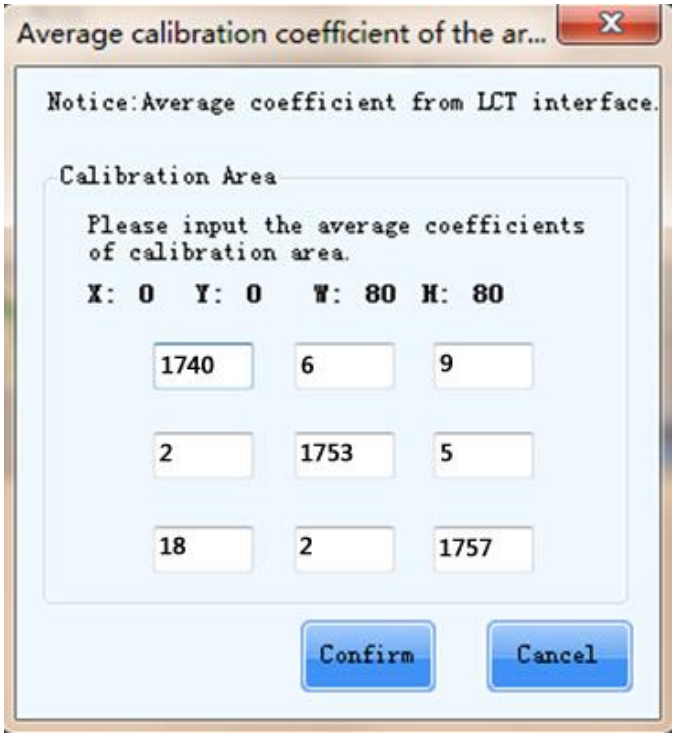
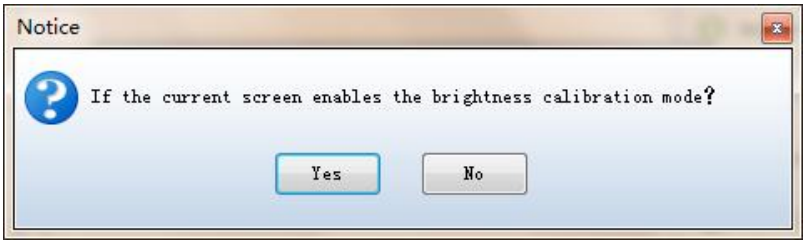


Fig.4-20 Input average calibration coefficient

5) Check if the brightness calibration is enabled on the offline calibration interface of LCT, if it is not, please enable it.



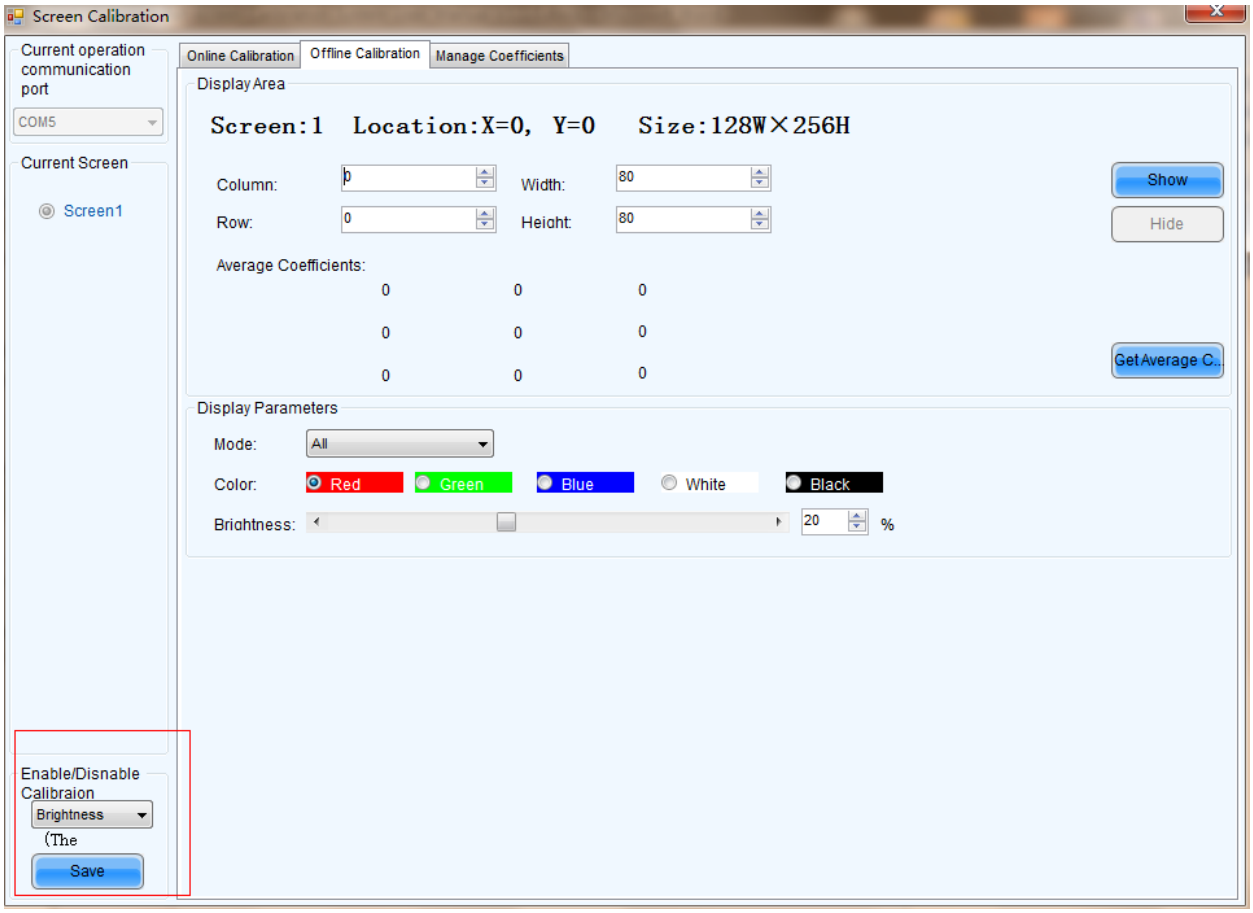
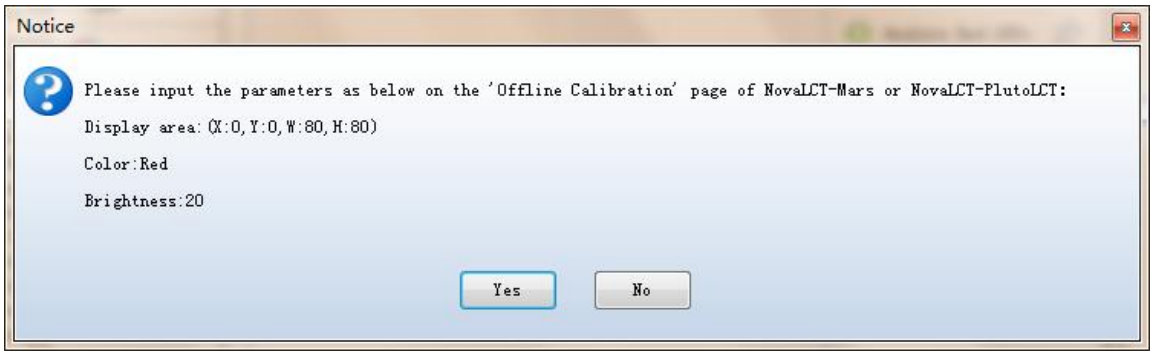


Fig.4-21 Enable brightness calibration

6) Set display parameters for offline calibration on NovaLCT.



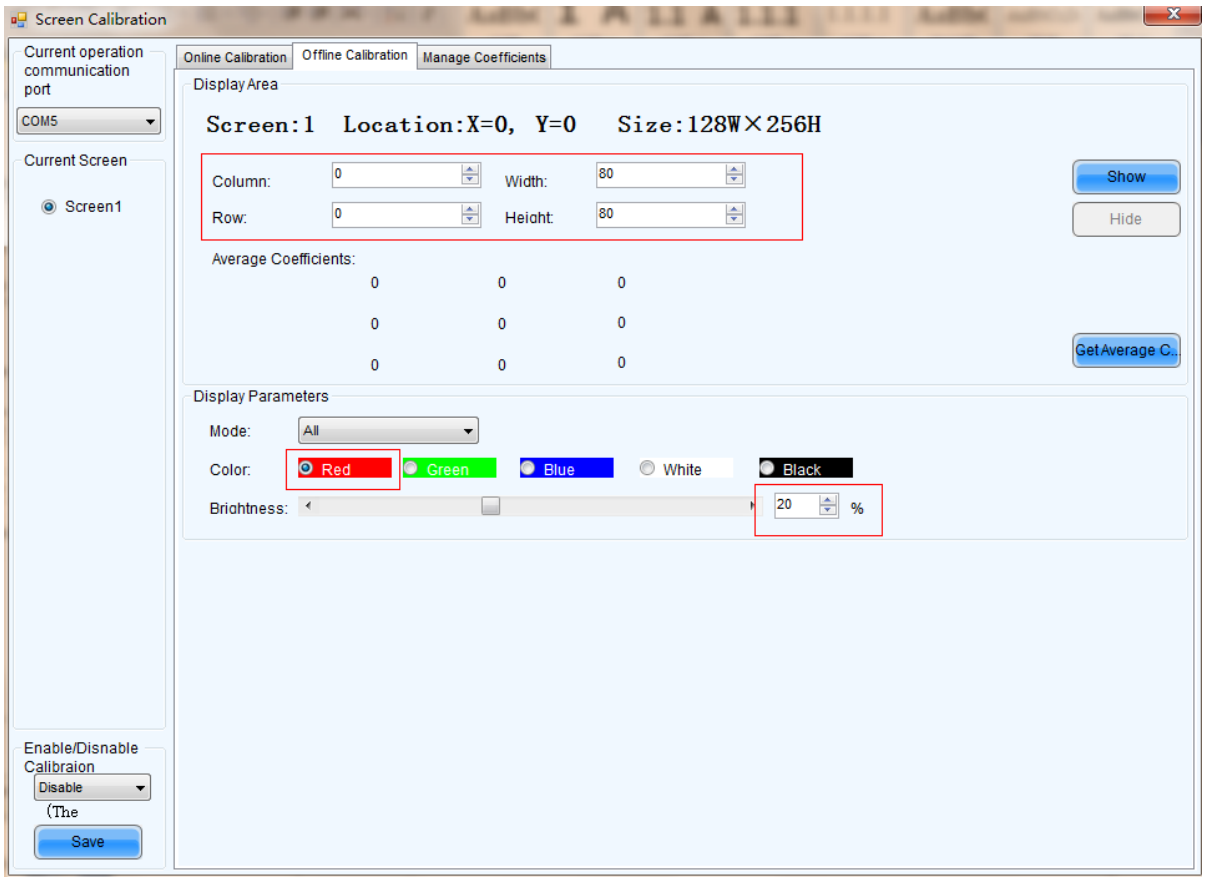


Fig.4-22 Set display parameters in offline calibrationmode

7) After completing setting, click "OK" to enable calibration, where the calibration procedure is the same as the online mode.

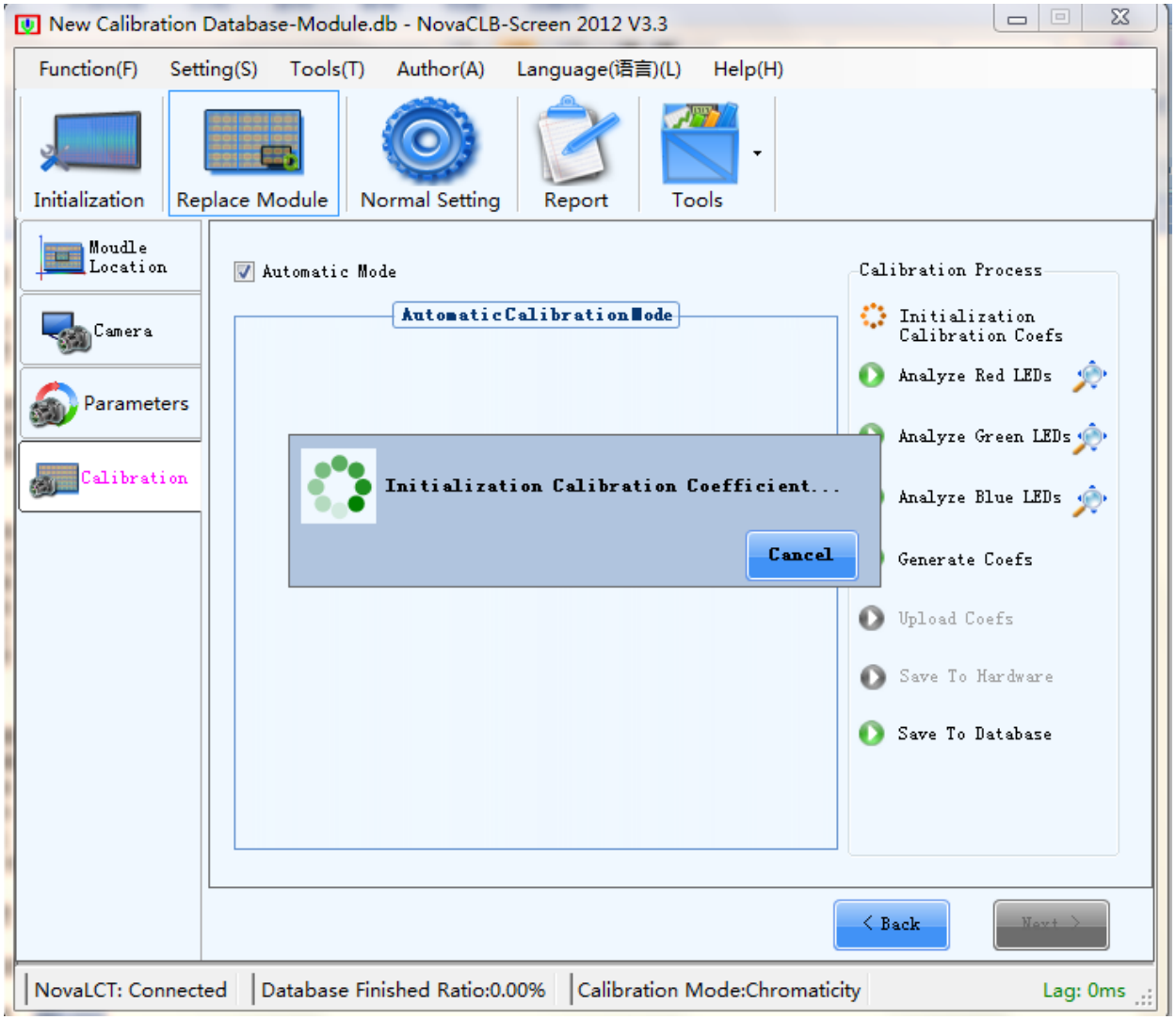


Fig.4-23 Module calibration（off-line)

5 Calibration interruption (Searching LED position failed)

No matter full-screen calibration or module calibration, after the calibration is enabled, various of problems at the site may cause led position failed leading to calibration interruption, such as screen binding, Dead LED or interference light. Generally, artificial location is adopted to help solve these problems, and this section will introduce solutions for several common situation.

1) Normal binding

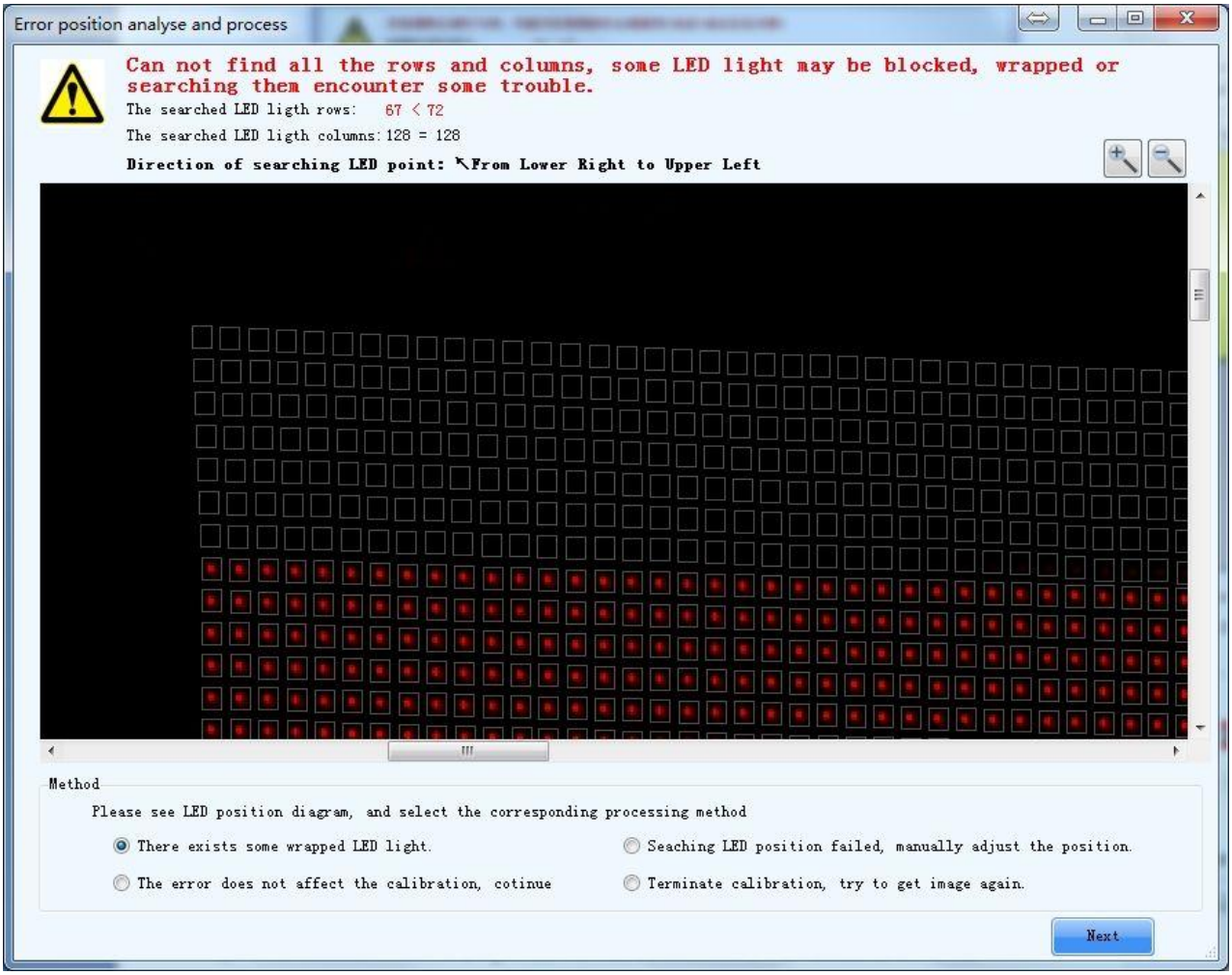
Normal binding means that the whole column or row at the edge of the screen is wrapped regularly, and the error of search appears as not enough detected columns and rows, as shown in the following figure:

Solution:

a) Tick "Binding existed, need detection", and click "Next".

b) The software detects four sides of the screen respectively, and the software defaults "Auto switch"; user needs to pay attention to the state of the software (namely at which row or column) while observing the lights lighting up at which stage of the screen, then record which state so as to select state at the "result" and click "Next".

c) After the four sides of the screen are detected, the software continues for calibration.



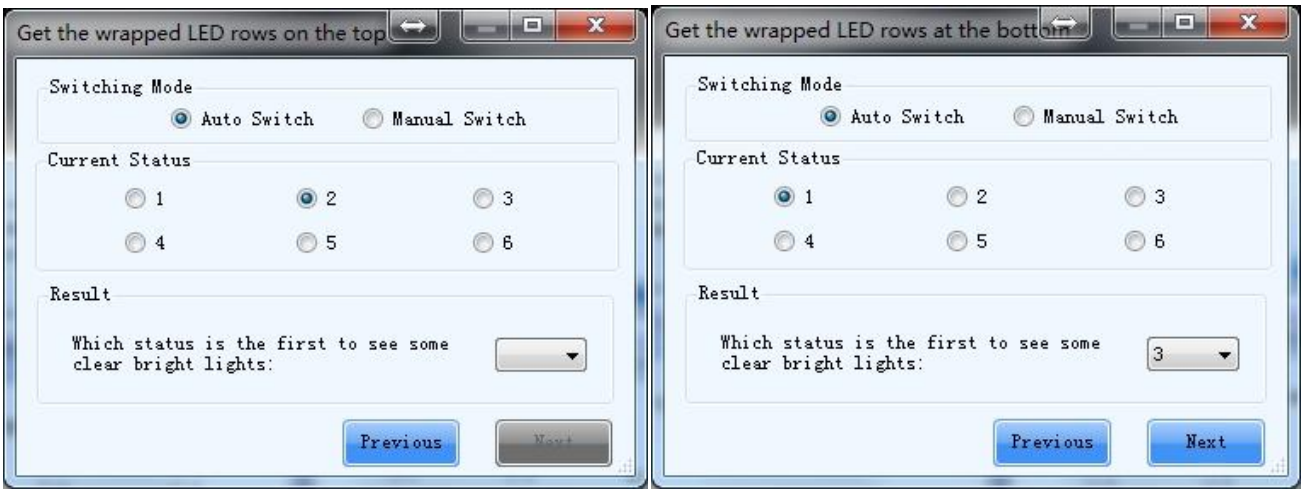


Fig.5-1Solution for Normal binding

2) User considers the binding to be normal, calibration can be forced to continue sometimes, user considers the binding to have little effect, then ticks "The error does not effect the calibration, continue", then click "Next" to continue calibration.

3) Dead LED is reasonable, continue calibration

The number and location of the Dead LED detected match the actual situation, which means that the screen actually has these Dead LEDs at these positions, and this situation is called normal Dead LED.

Solution:

Method 1. Check "Dead LED is reasonable, continue calibration", and click "Next" to continue calibration.

Method2. Check “Modify the dead led radio allowed ” to adjust the proportion of dead lamp higher.

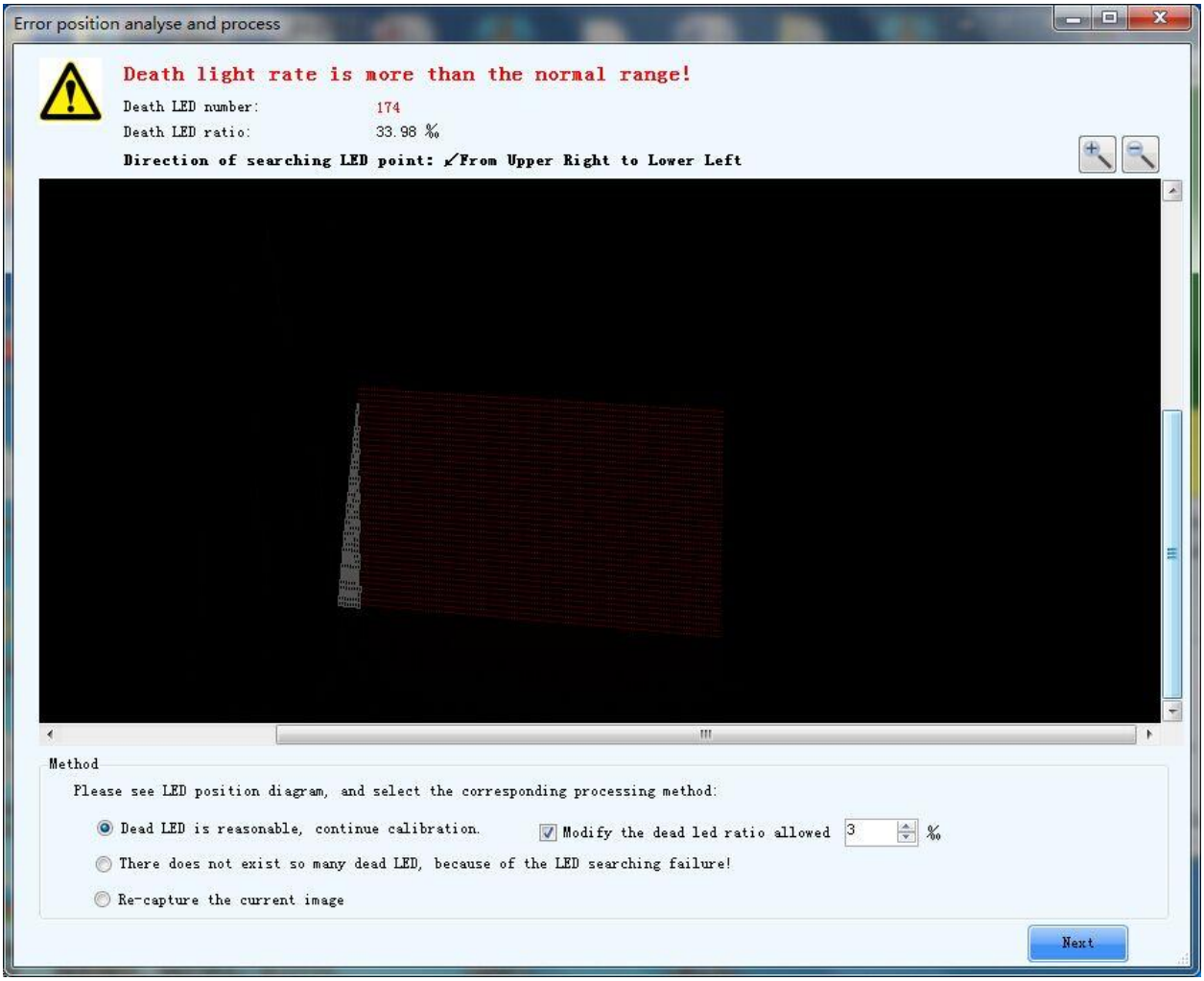


Fig.5-2 Dead LED is reasonable

4) Dead LED increased by failure of searching

The detected Dead LEDs are most fake Dead LEDs, which means that the actual screen does not have so many Dead LEDs.

Solution:

a) Tick "There does not exist so many Dead LED because of the LED searching failure", and click "Next";

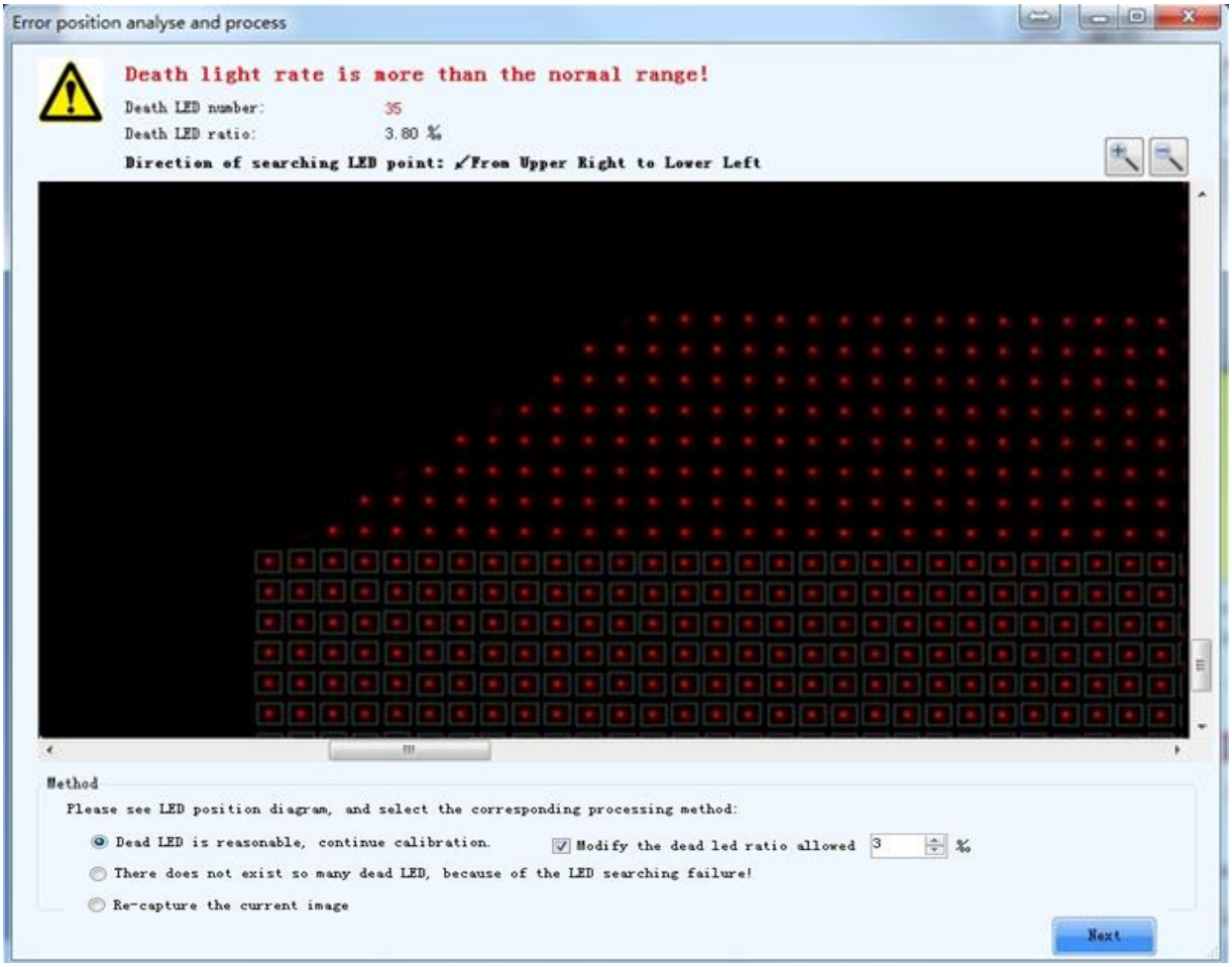


Fig.5-3 Death light rate is more than the normal range

b) Adjust the first wrong LED point on the searching direction to right position, then click "search again".

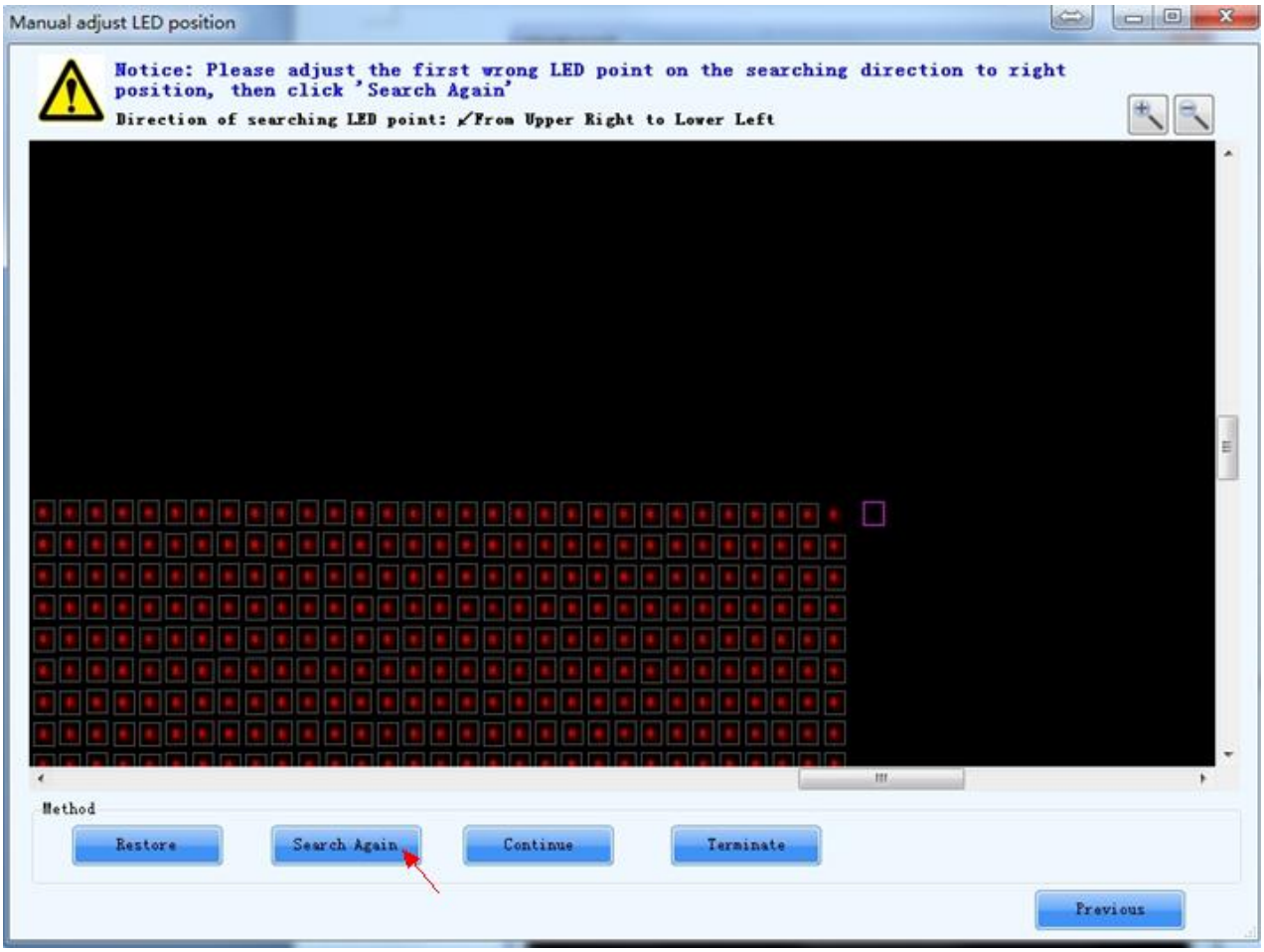


Fig.5-4 Search Again

Restore: Restore to the state of the last search;

Search again: Conduct search again according to the current location direction and initial point;

c) After the searching is successful, continue calibration.

5) Dead LED at the location initial position causes searching inconsistent rows and columns

If the location initial point has Dead LEDs, part of the lights may be bypassed during location monitoring, which will cause inconsistence between detected rows and columns and the actual situation.

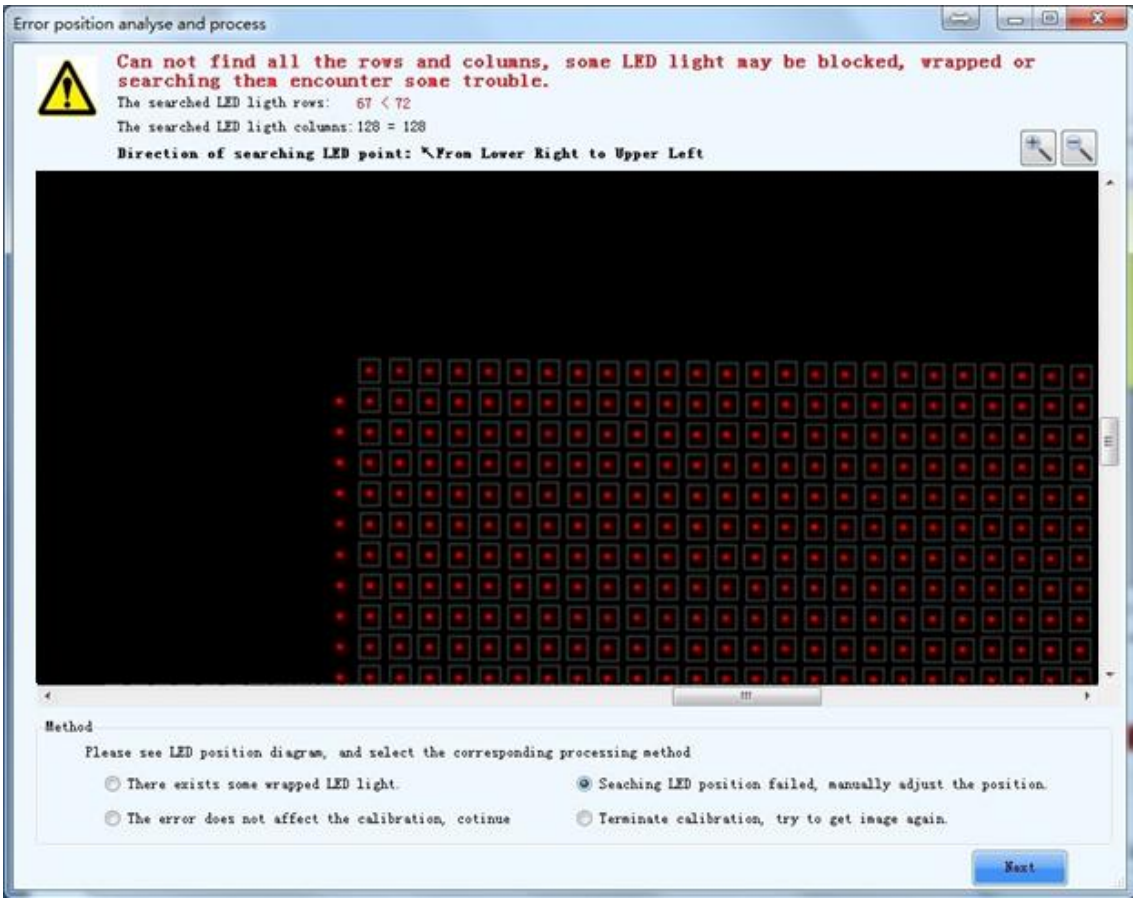


Fig.5-5 Dead LED at the location initial position

Solution: Tick "Searching LED position failed, manually adjust the position", and re-select the location direction, switch to a start direction without Dead LED so as to conduct search again.

6) Search result differs a lot with actual situations, calibration abandoned

If the result of search differs a lot with the actual situation, for example, Searching result is that there are Dead LEDs at the up side and down side of the screen, but actually, there are Dead LEDs at left and right sides, under this situation, it is suggested to abandon calibration.

7) The number of rows and columns increases in the detection result

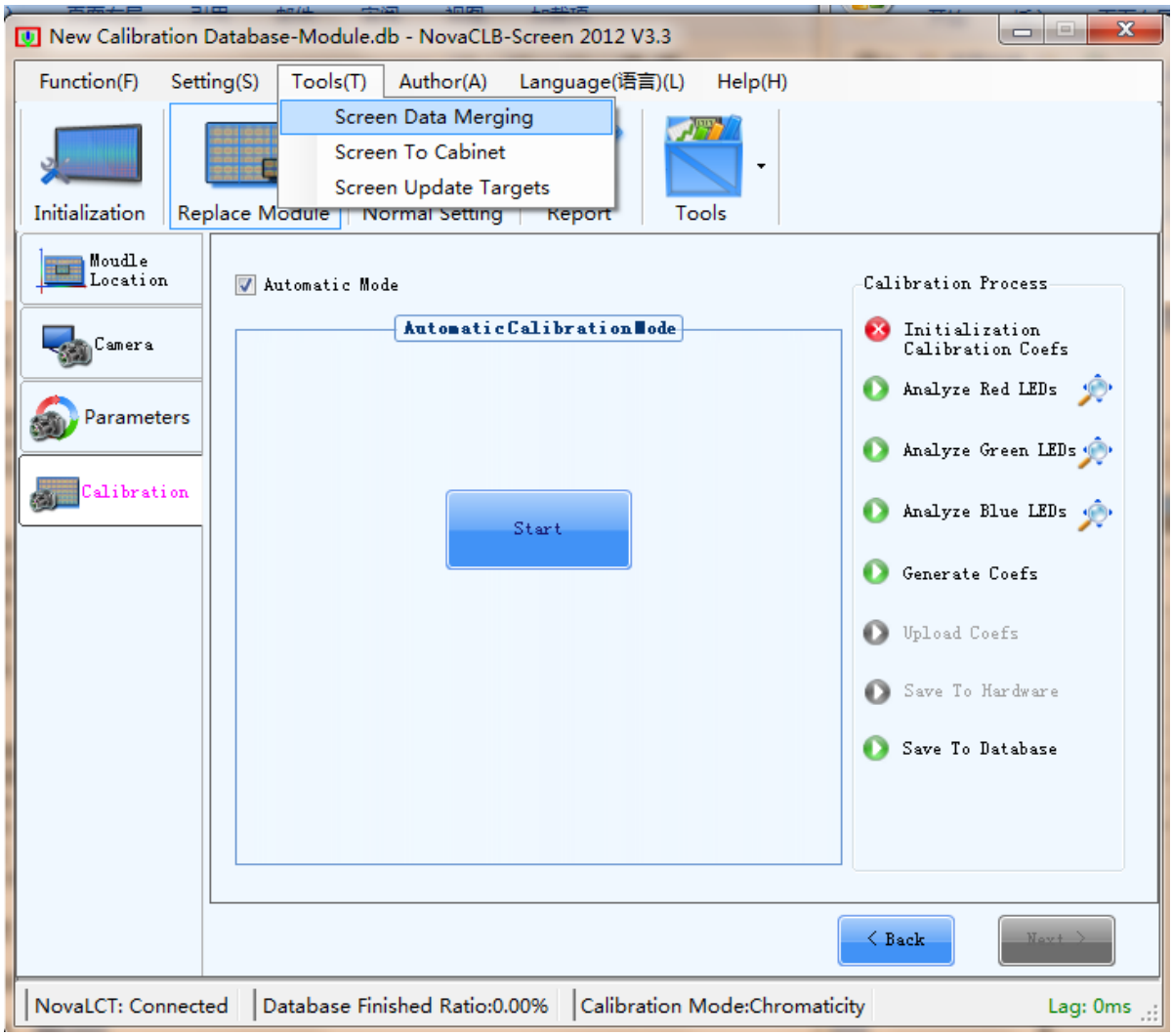
The result of search failed is that the number of rows or columns is greater than actual situation.

Solution: This result is caused by two possibilities: one is interference light which is eliminated as the solution; the other is that the resolution of sending card is inconsistent with that of graphics card, then the resolution of the sending card shall be set on LCT.

6 Full Screen Data Merging

Spot calibration often encounters such situation: a large screen is applied with multiple sending cards for loading, and a video processor and a video stitching device are used between the graphics card and the sending card to connect the frames; at this moment, the display and the large screen are not in point-to-point display, and during calibration, the video process equipment needs to be skipped, and the large screen shall be divided into multiple split screen for respective calibration; and after calibration, unsmooth transition may appear at the adjacent area of the split screens, which is commonly known as layering. The full screen date merging tool is for solving this problem.

At the main interface of the software, click "Tools"→"Screen Data Merging"; after opening the tool, assume that the full screen has been divided into four regions for calibration, set 2 rows and 2 columns of split screen.



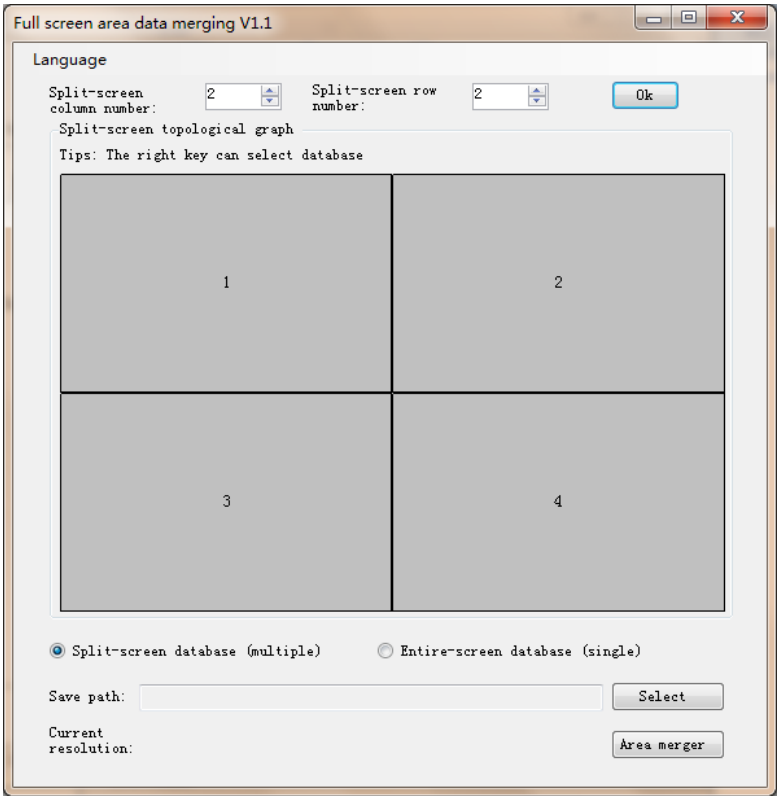


Fig.6-1 Full screen region data merging

Select one of the regions, click right button of the mouse → "Select database", load the corresponding full screen database; after loading successfully, see the information related to the database; and load the full screen database corresponding to all regions according to the same procedures, as shown in the figure below.

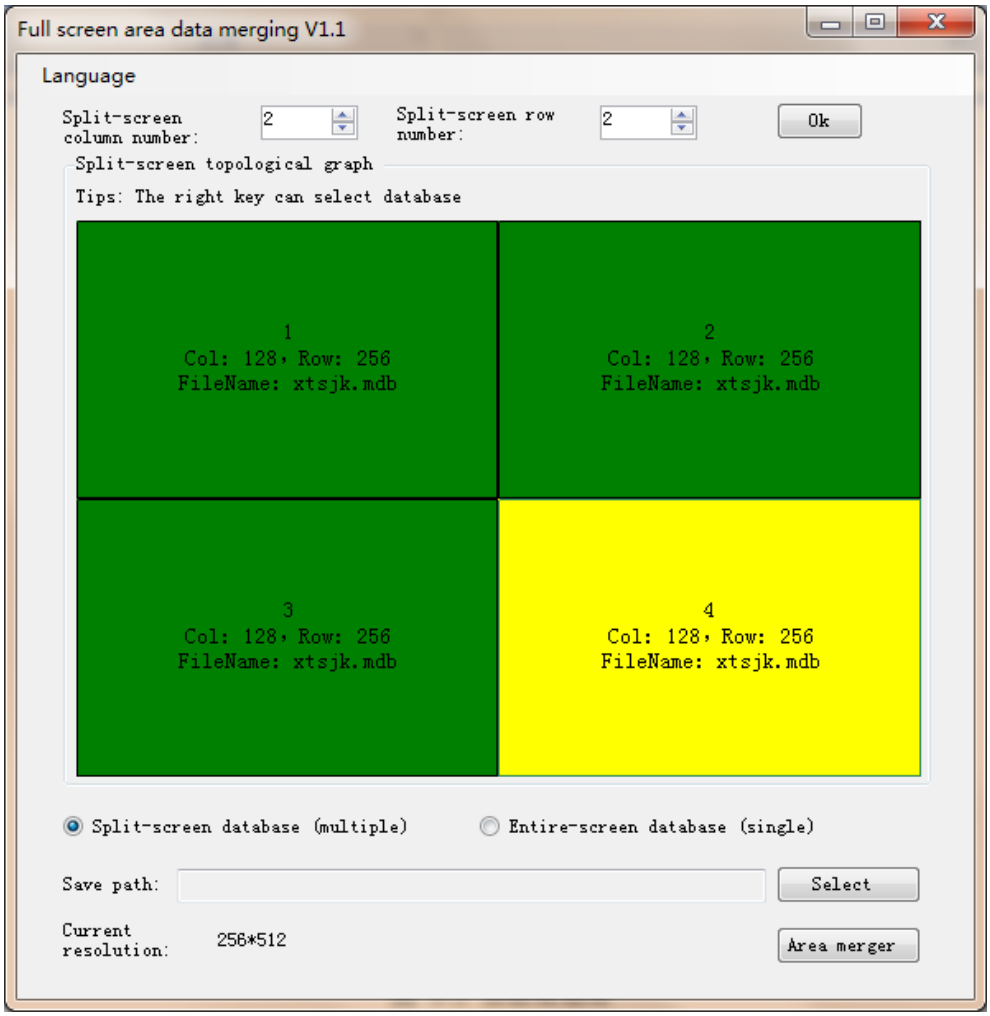


Fig.6-2 Loading the database

Click "Select" to set the storage directory for the database generated after merging.

Pay attention to whether current resolution ratio of all regions are match to the full screen resolution or not; after confirming they are matched, click "Area merger".

If the option "Split-screen databases" is checked, four databases after merging will be generated; if the option "Entire-screen databases" is checked, one database will be generated after merging.

7 Screen Update Targets

If the brightness and chroma of the full screen is not satisfactory after the calibration is completed, the full-screen target value can be modified through this function.

The operation is as follows:

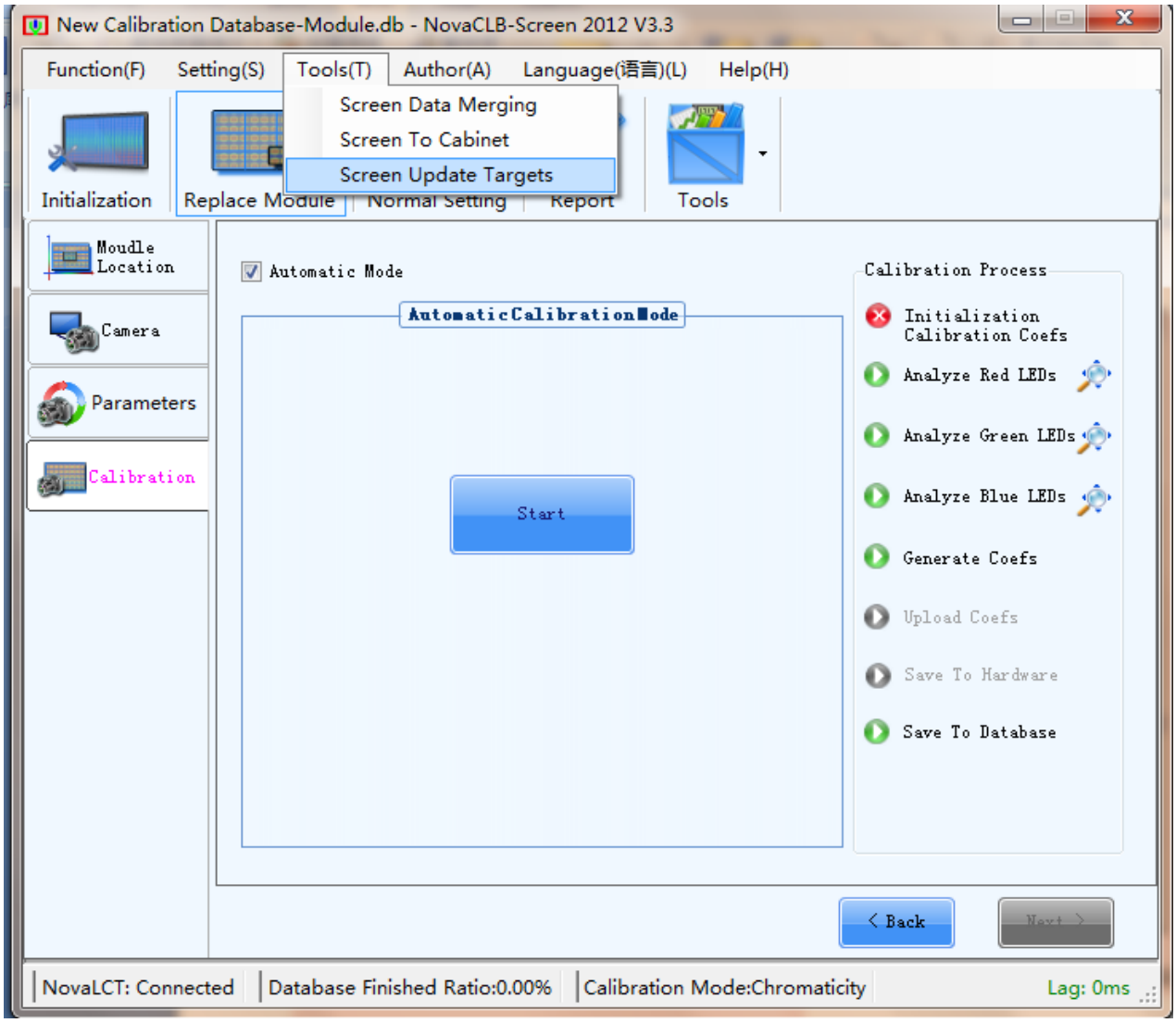


Fig. 7-1 Screen update targets

Click the first Broswer to import the original database, and click the second Broswer to set the route of the target database.

The modification method of the target value is the same the setting of “Expected brightness and chroma”.

After the modification is completed, click Apply to save and apply the target value.

Click the first Broswer to import the original database, then click the second Broswer to set the path of the target database.

The target value can be changed in the same way as the setting of "expected brightness and chroma".

After the change, click Apply to save the target value and apply.

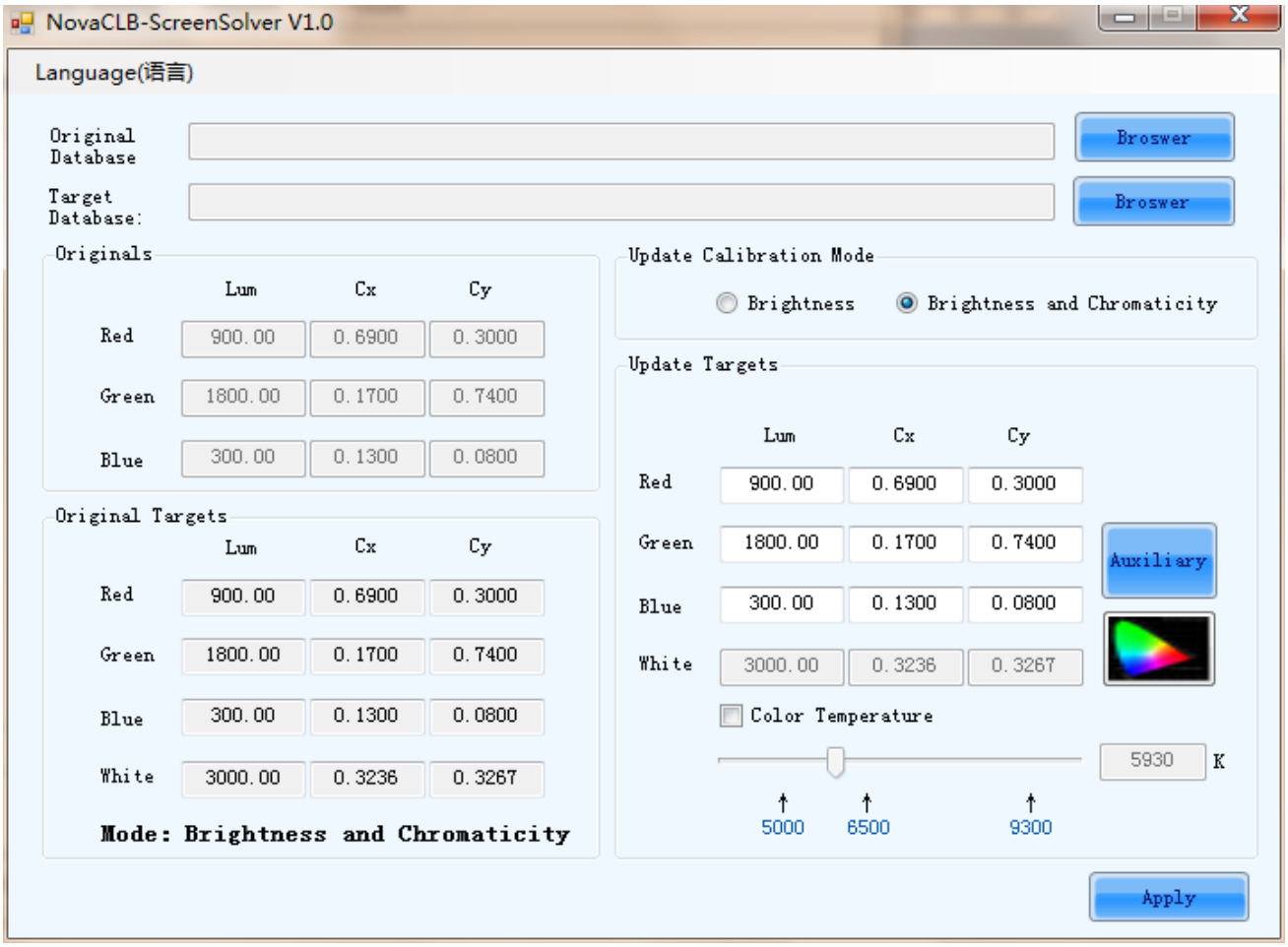
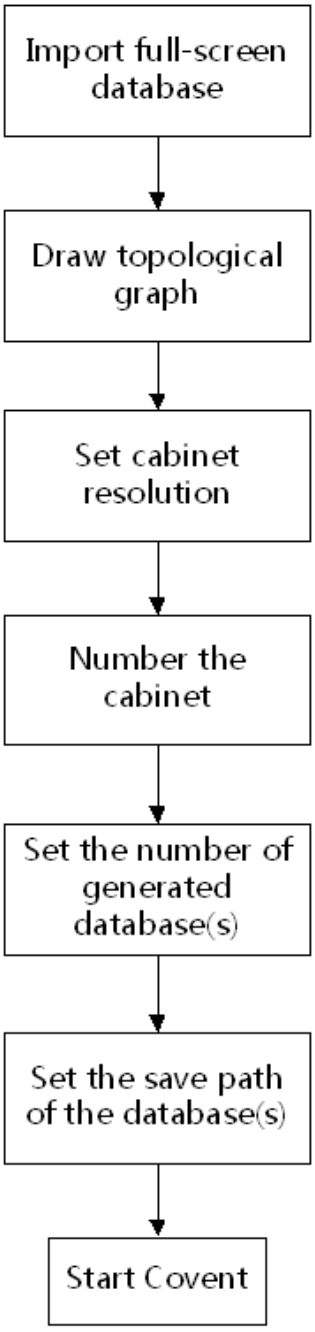


Fig.7-2 Screen Update Targets

8 Full-Screen Converting Cabinet

Full-screen converting cabinet software can switch the full-screen database into cabinet or module database according to a certain resolution. It can be switched to single database or multiple databases based on different needs.

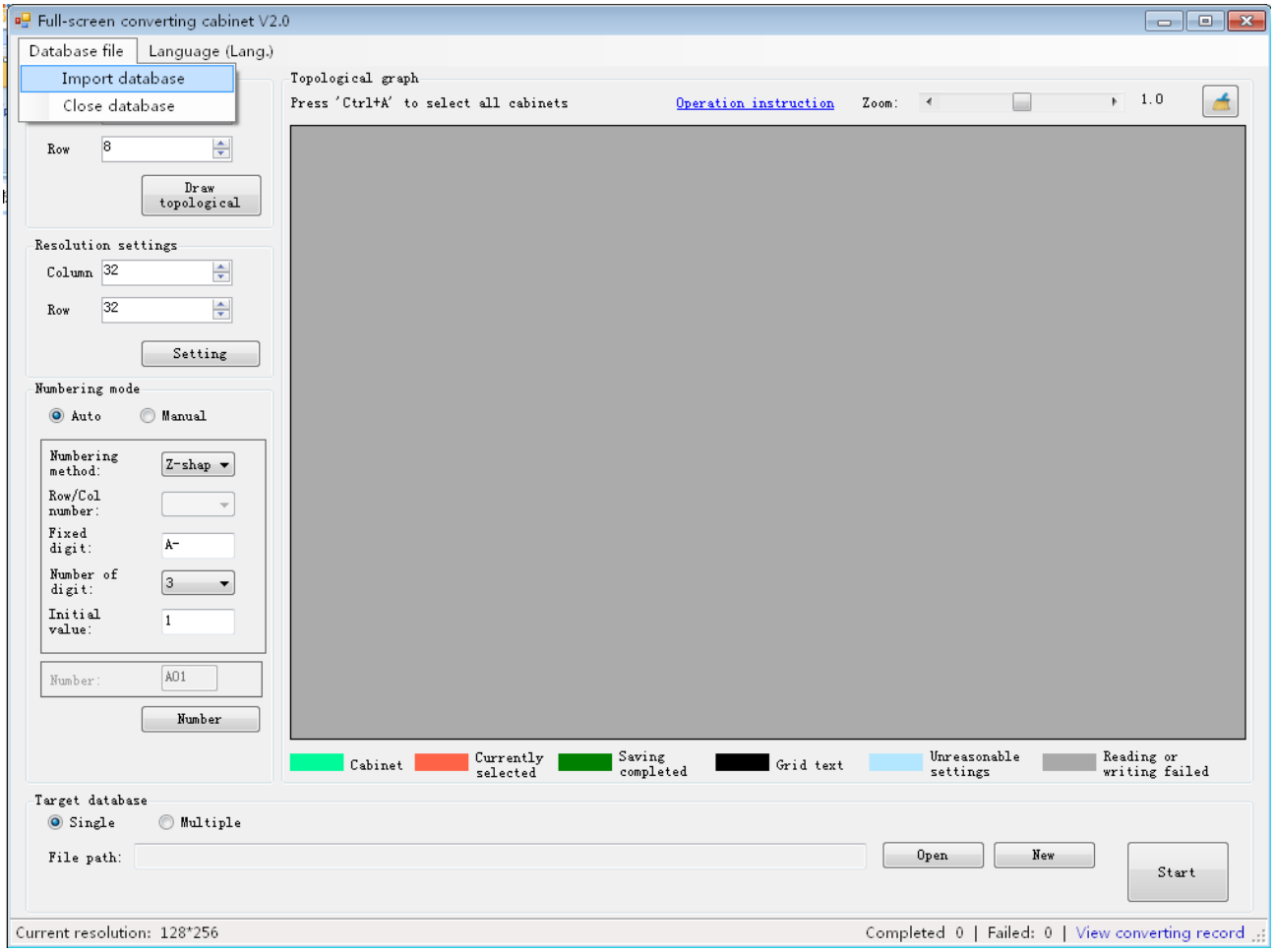
8.1 Operation procedure



8.2 Operation instruction

This chapter will illustrate operation steps of all procedures for users in detail.

8.2.1 Import database



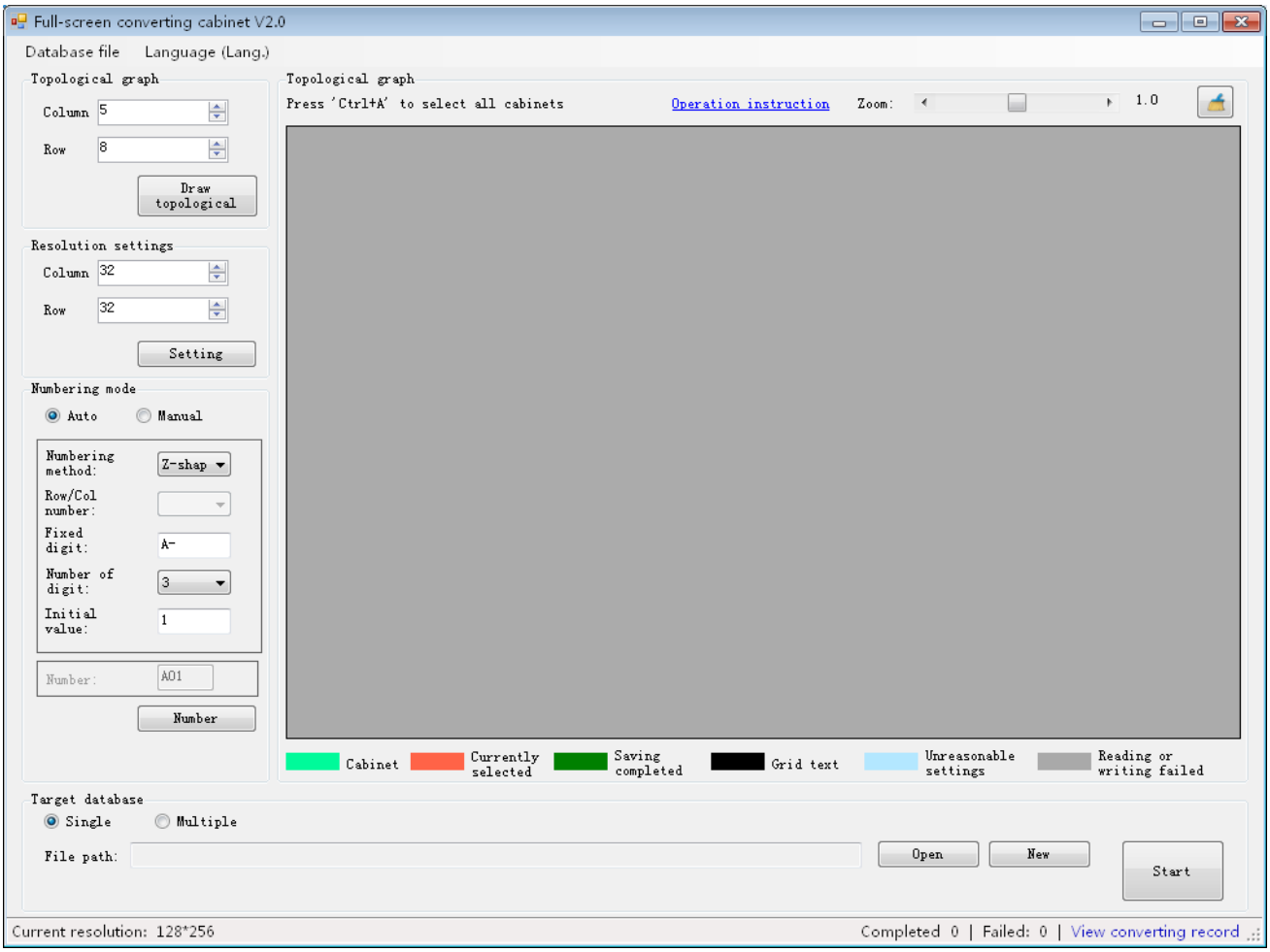


Fig. 8-1 Import Full-Screen database

8.2.2 Draw topological graph

Set the number of row and column of the cabinet, and then click 

to generate a topological graph in the right window of the software.

Note that the sum of the resolution of all rows and all columns of the cabinet shall be equal to the resolution of the screen; therefore, under the premise that resolution of each cabinet is known, number of rows and columns of the cabinet shall be calculated accurately.

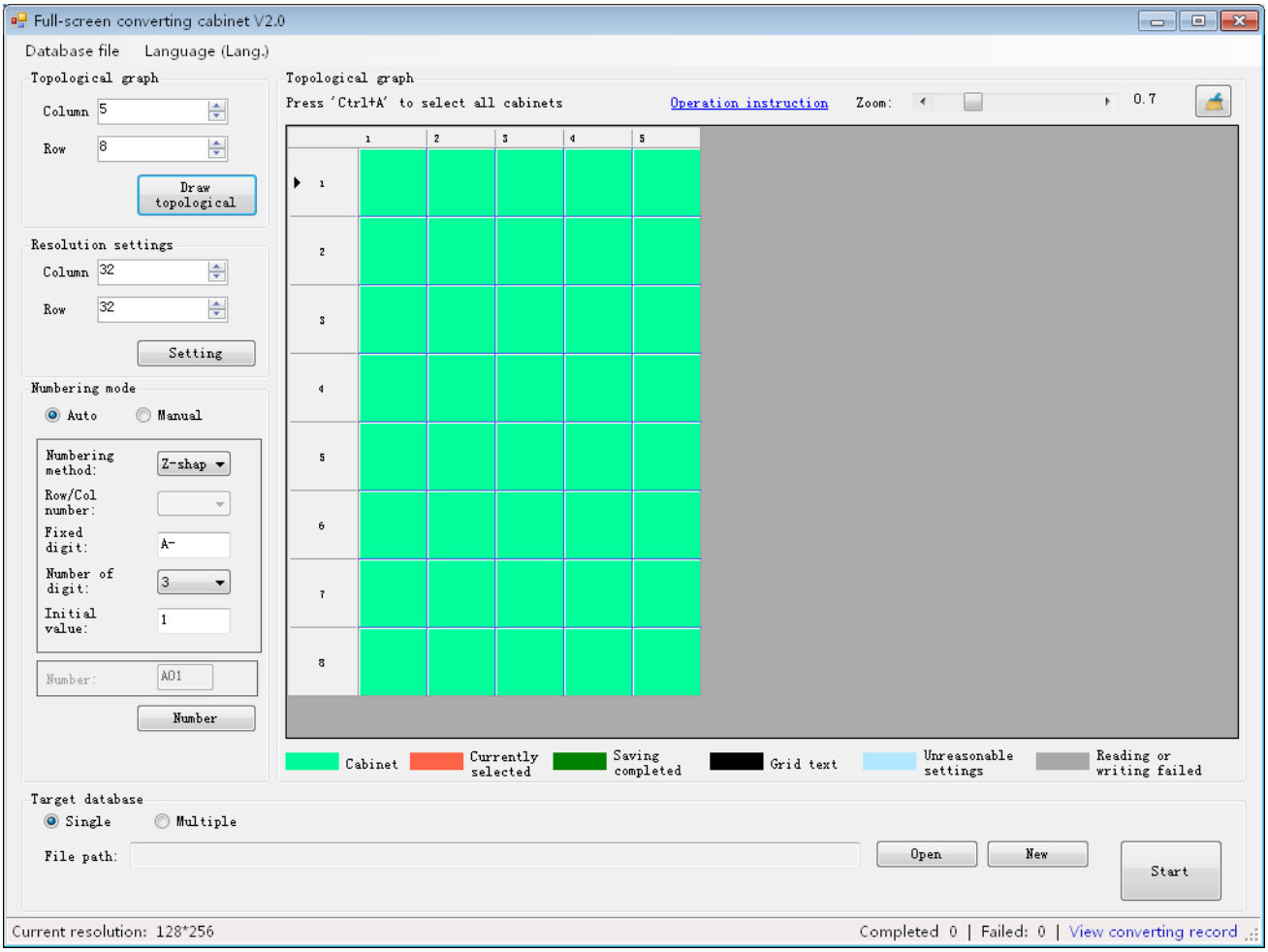


Fig. 8-2 Draw topological

8.2.3 Set resolution of each cabinet

First, select the cabinet which will be set in certain resolution, then set the resolution, and click 

.

The cabinets can have different resolution; however, for cabinets on the same row, row number of the resolution shall be the same, and for cabinets on the same column, column number of the resolution shall be the same; when the resolution setting is irrational, the color will appear; the sum of the resolution of all rows and all columns of the cabinet shall be equal to the resolution of the screen.

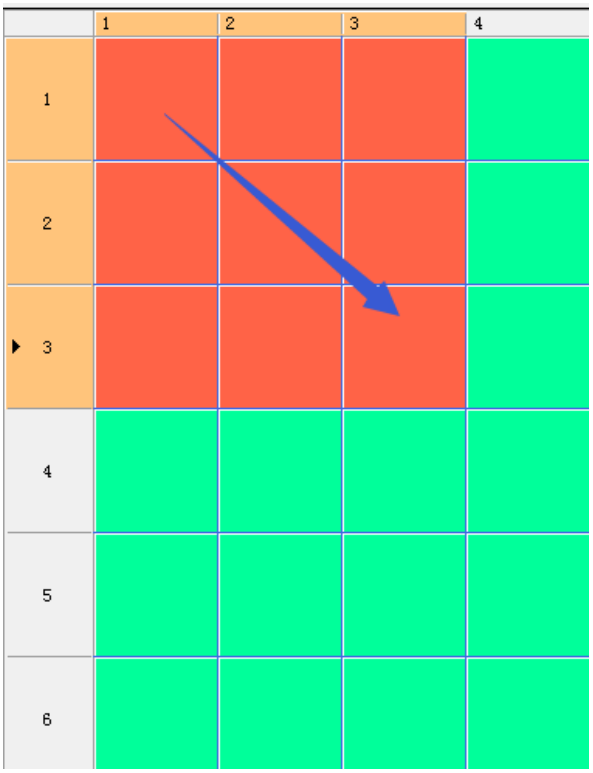
Instruction of the right-click menu of the cabinet:

Right-click on the topological graph will show two options in the right-click menu, "Partition

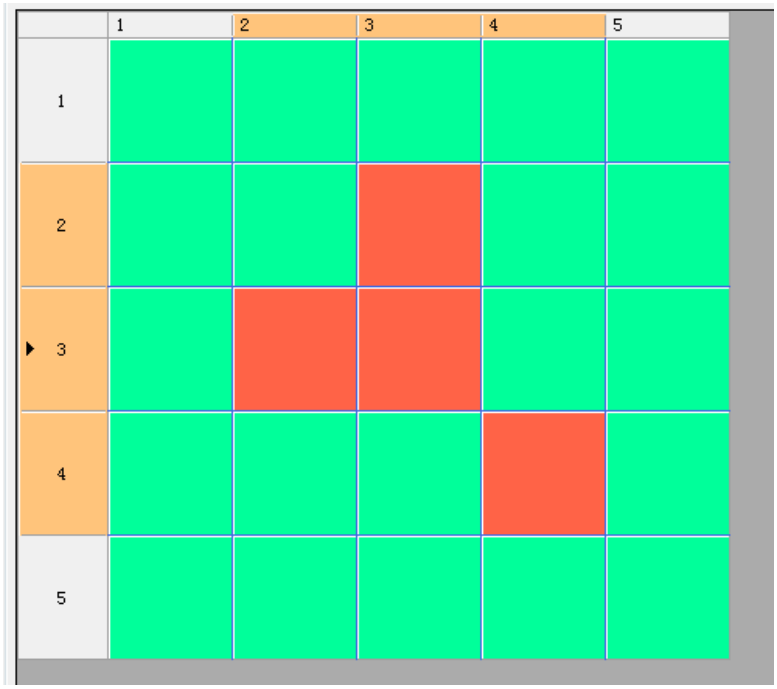
averagely" and "Clear settings". " Partition averagely": partition the resolution of the display averagely on the drawn topological graph of the cabinet with resolution of each cabinet being the same. "Clear settings": clear the resolution and cabinet name set on the topological graph.

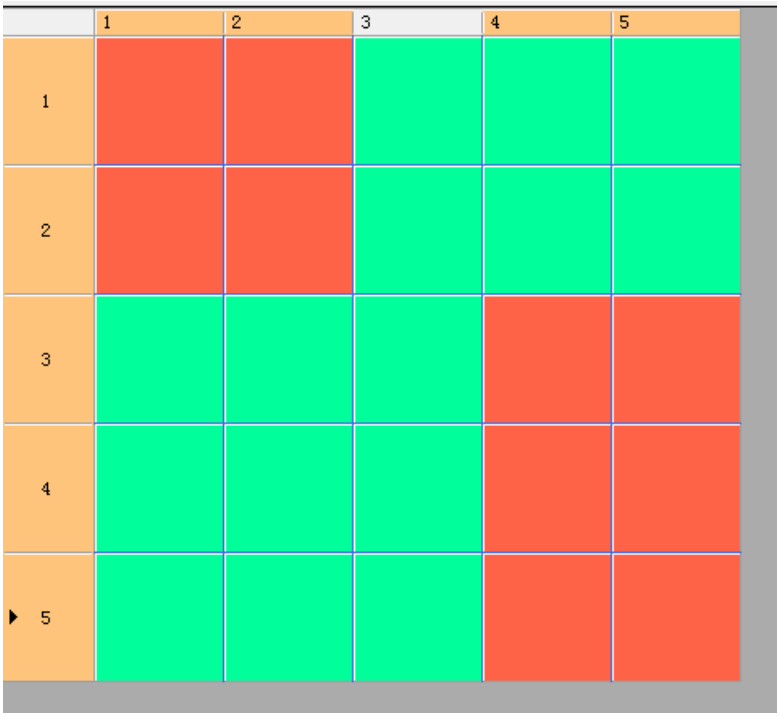
The following methods can be used to select the cabinet:

a) Select the first cabinet, hold down the mouse and drag according to the direction of arrow in the figure; the result is as follows:

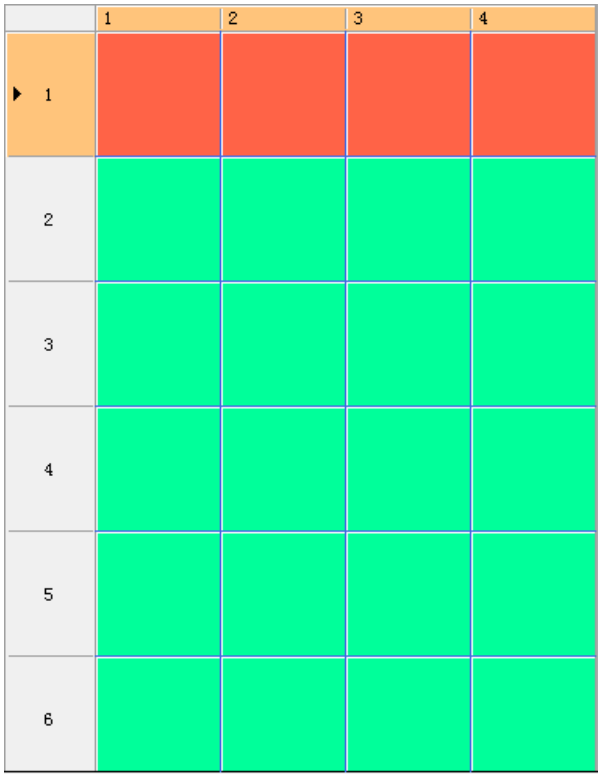


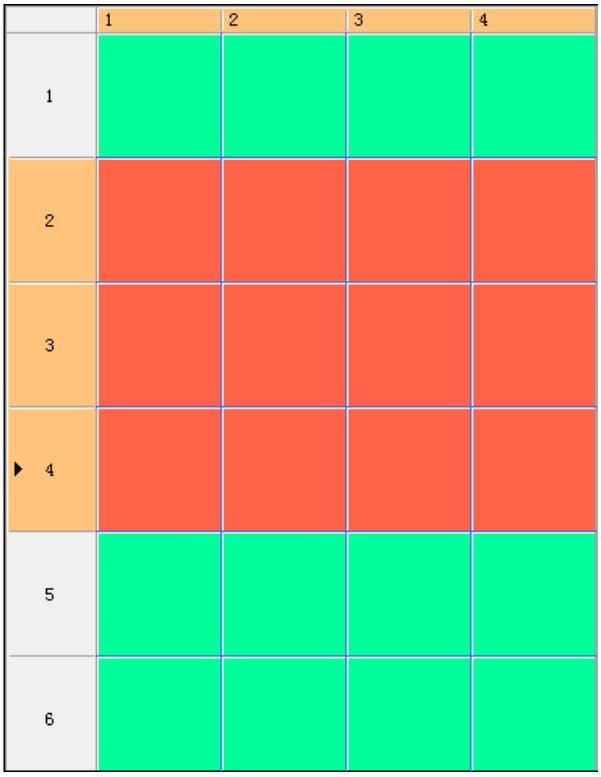
b) Press the "Ctrl" key to conduct multiple selections; the result is as follows:



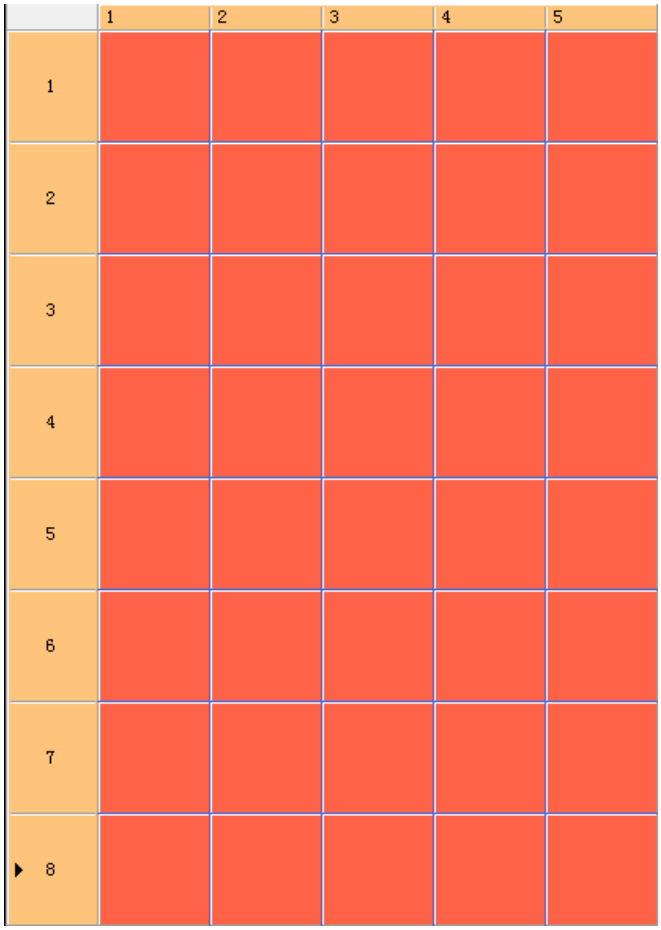


c) Select one cabinet as the start, press the "Shift" key, and then select another cabinet as the end; in this way, the rectangular area from the start cabinet to the end cabinet can be selected; the result is as follows:





d) Press "Ctrl+A" to select all cabinets; the result is as follows:



The topological graph with set resolution is shown as follows:

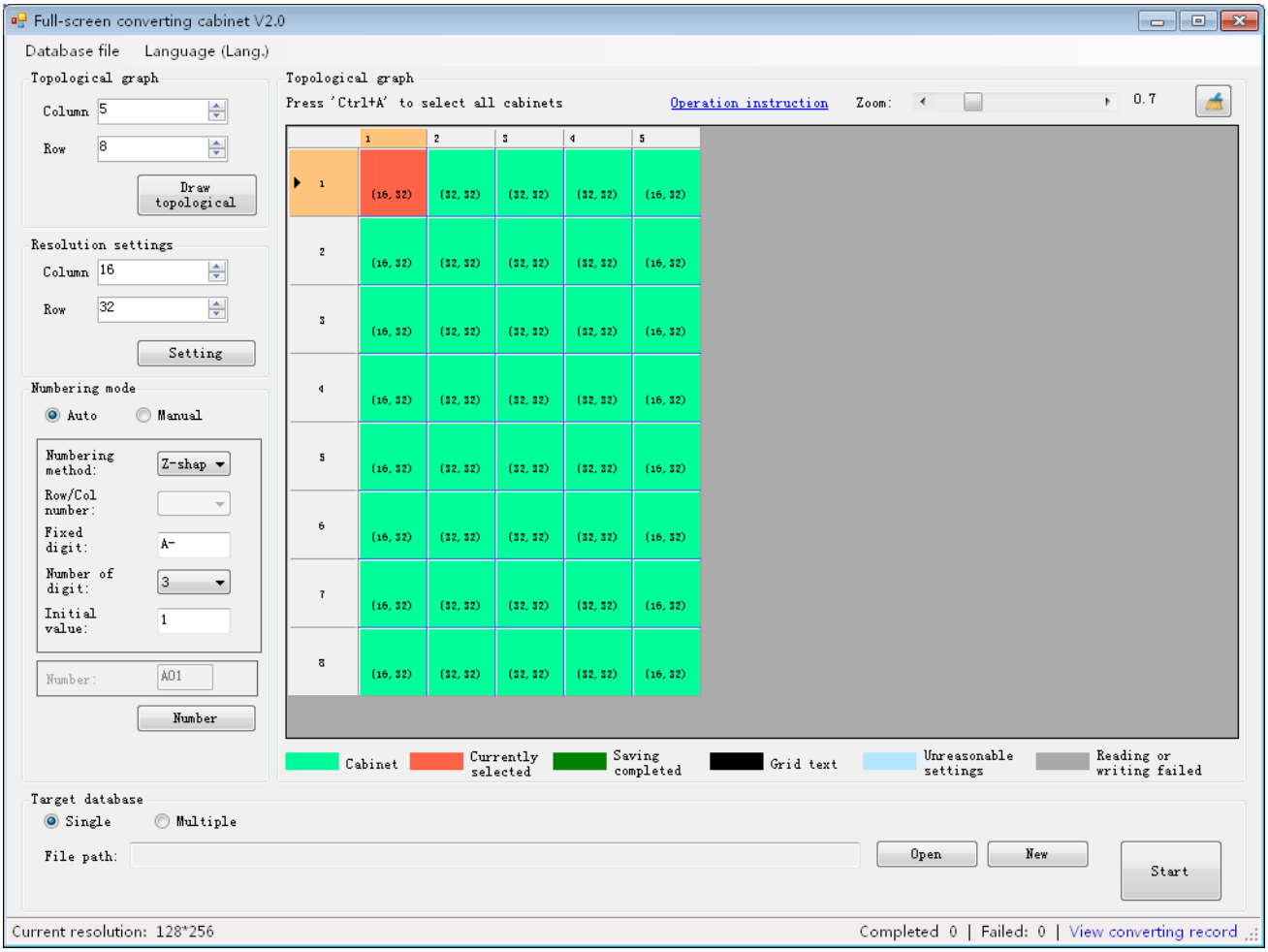


Fig. 8-3 Set resolution of cabinet

8.2.4 Number the cabinet

Numbering can be automatic or manual.

1) Automatic numbering

Check "Auto", select numbering method, row/column number, number of digit, and set fixed digit and initial value, and then click 

.

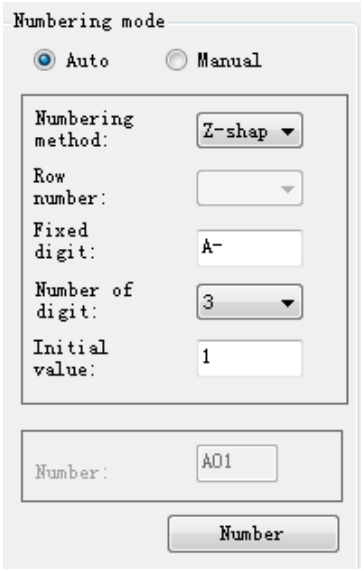


Fig. 8-4 Select Auto numbering mode

Numbering method: column direction, row direction, Z-shaped.

Row/column number: When selecting column direction and row direction, it needs to select the first row/column, the second row/column, the third row/column,....., the nth row/column, and number them respectively; the following figure is the topological graph after being numbered.

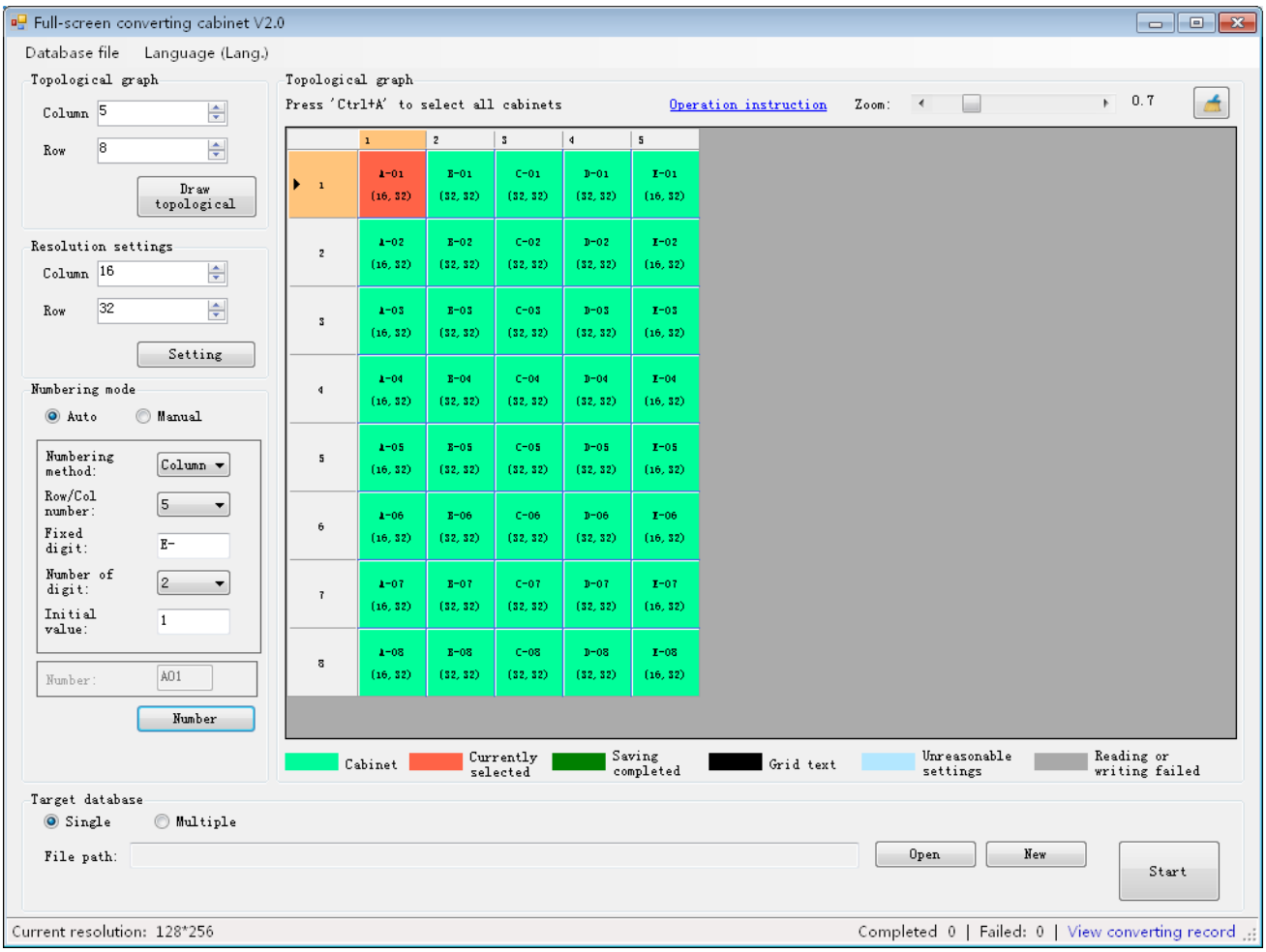


Fig. 8-5 Row/column number method

If Z-shap is selected, there is no need to select row/column number every time; the software will number all the cabinets according to the Z-shap, as shown in the following figure:

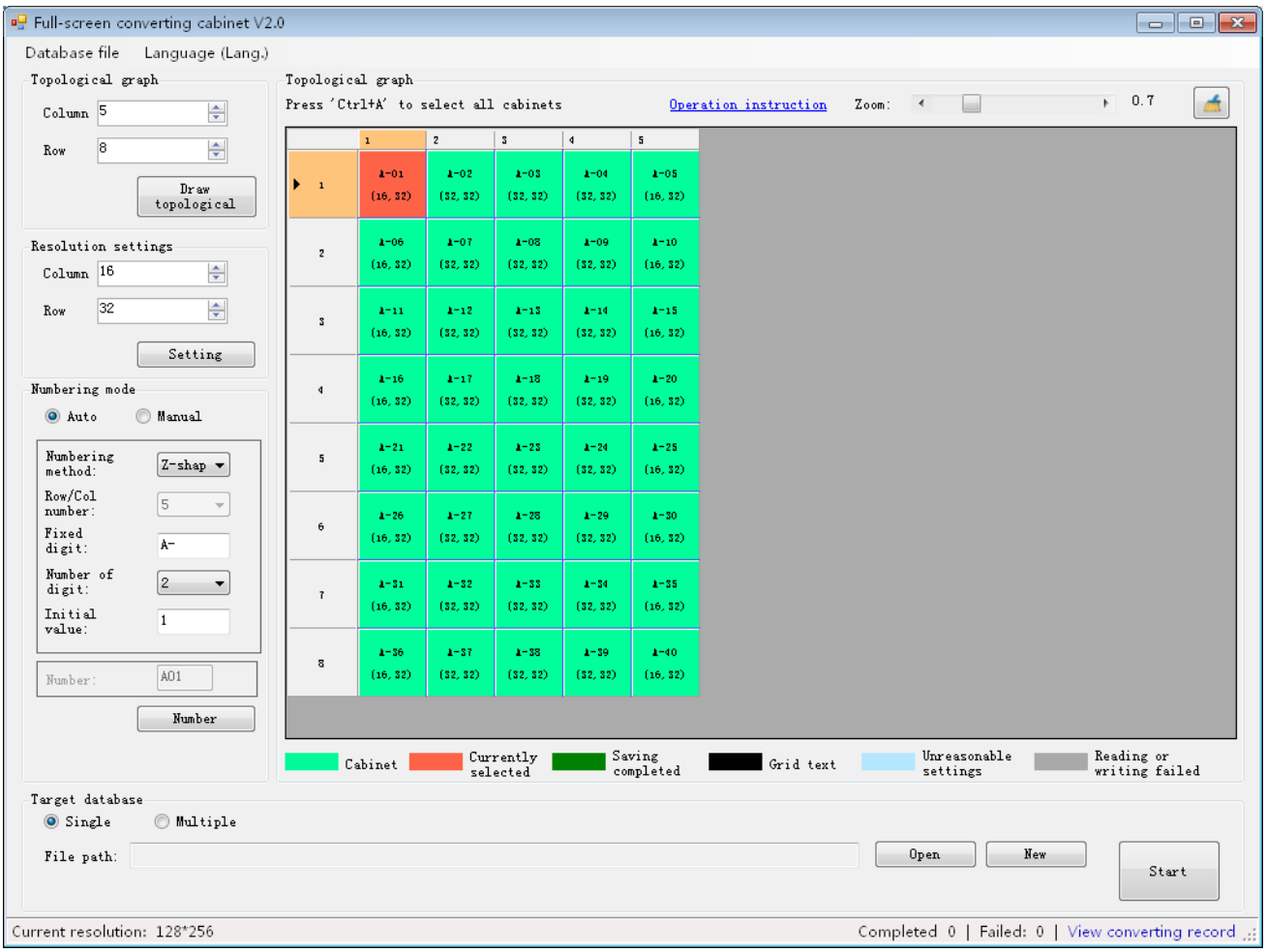


Fig. 8-6 Select Z-shap numbering method

Fixed digit: fixed numbering character at the beginning of the number which can be set by the user; it can be any character, for example, A-, B-, number-, etc.

Number of digit: number of digit for the number, 1-4 digits; as shown in the following figure, the numbers of the first and second column have 2 digits; the number of the second column has one digit; the fourth column has 4 digits; and the fifth column has 3 digits.

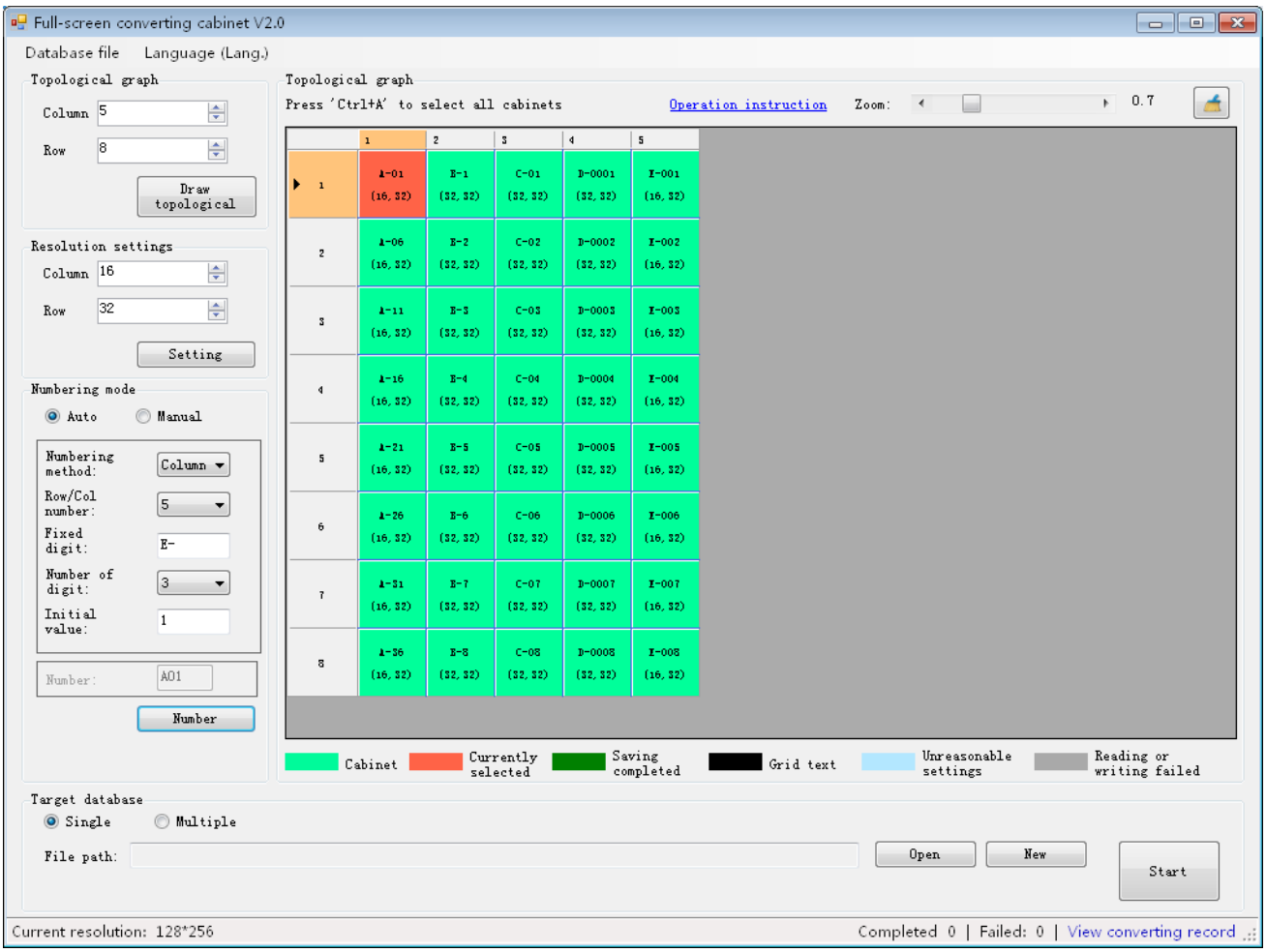
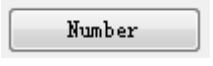


Fig. 8-7 Set the number of digit

Initial value: it means the initial value of the digit position in a single numbering process; for example, A-01 to A-08 can be used for the first column, and the initial value of the second column can be set as 9.

2) Manual numbering

Each time, number shall be entered manually; for example, enter the number A01, select the first cabinet, and then click 

to finish the numbering of the first cabinet; then enter A02, select the second cabinet, and then click 

to finish the numbering of the second cabinet; and the following can be done in a similar way to finish numbering of all cabinets.

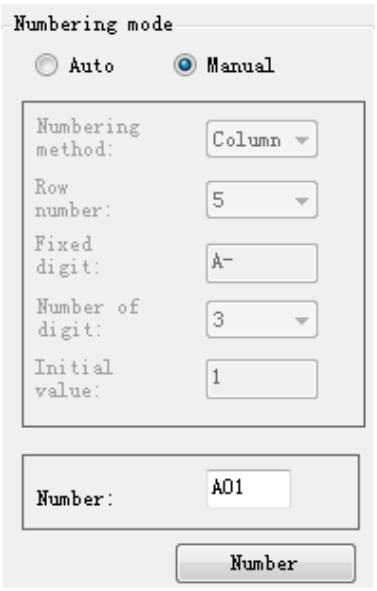


Fig. 8-8 Select Manual numbering mode

8.2.5 Set target database

There can be single target database or multiple target databases. For single target database, all cabinets or modules will be saved to one database and one database will be generated. For multiple target databases, single cabinet or module will be saved as one database, and multiple databases will be generated which are named after the number of each cabinet or module.

8.2.6 File path

In the case of saving as one single database, there are two situations. One is to save the cabinet data to the existing database which requires clicking Open to open the existing database. The other is to save the cabinet data to a new database, which requires clicking New to create a new database on some path of the computer.

In the case of saving as multiple databases, click Open to select the saving path of the cabinet database.

8.2.7 Switch

After completion of settings of all the options above, Check the cabinets that to be converted on

the topological , And then ,click 

.

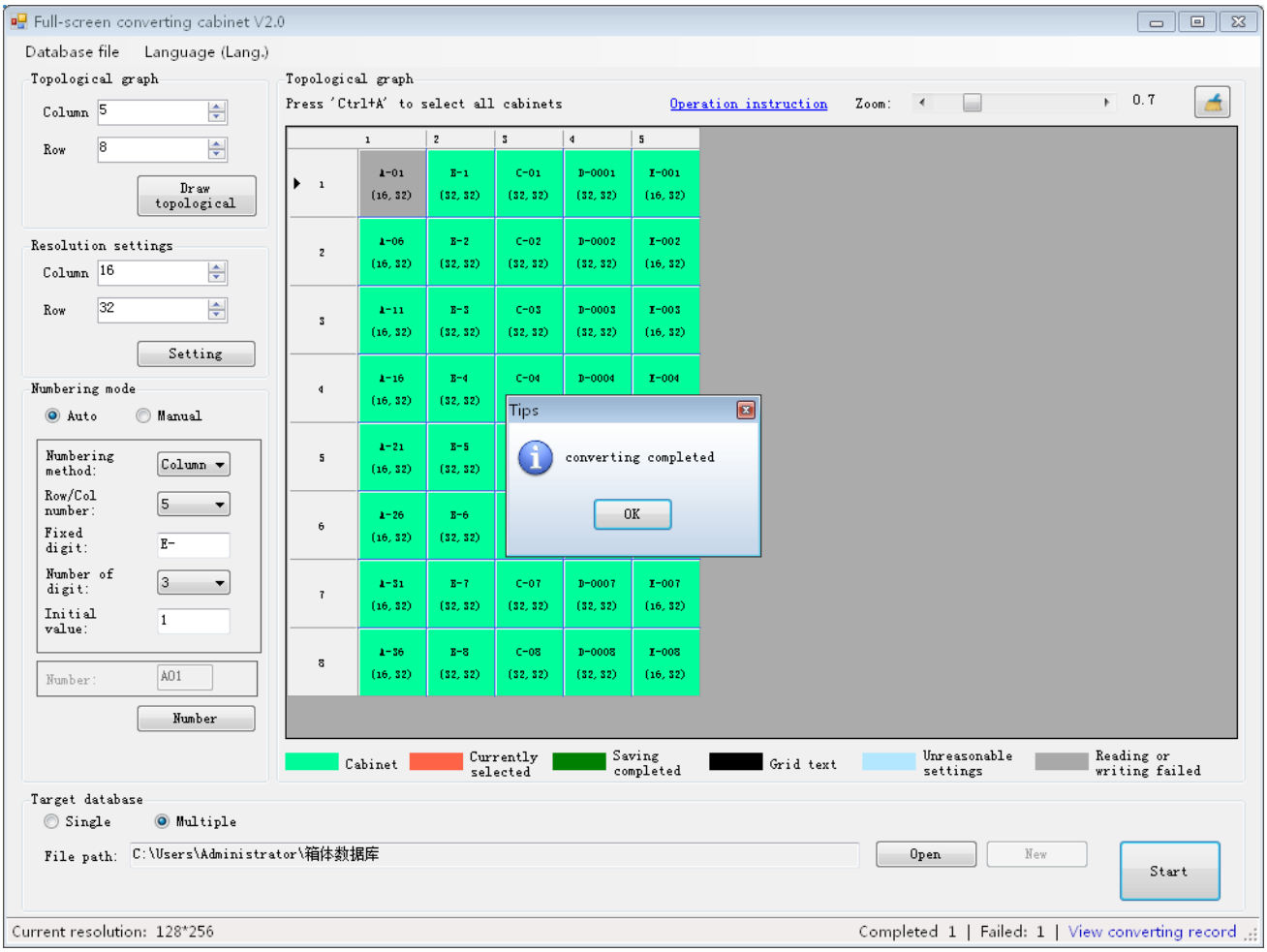


Fig. 8-9 Converting completed

9 NovaCLB-Screen Help

9.1 Network Settings

If the distance between the calibration computer and the NovaLCT control computer is within 100m when performing calibration, Ethernet cables can be used to connect the two computers. Otherwise, wireless routers should be used.

Here TP-LINK WR941N will be taken as an example for illustrating how to configure a wireless router for calibration application:

Fig.9-1 The Wireless router TP-LINK WR941N

1) Connect the wireless router with the control computer through the network cable into the yellow interface.

Fig.9-2 Ports for Connection

2) Enable the wireless networking capabilities of calibration computer to connect to wireless router.

Pay attention, whether use network cable or wireless router, you need to set the IP of the two computers and the default IP of wireless router to be within the network segment.

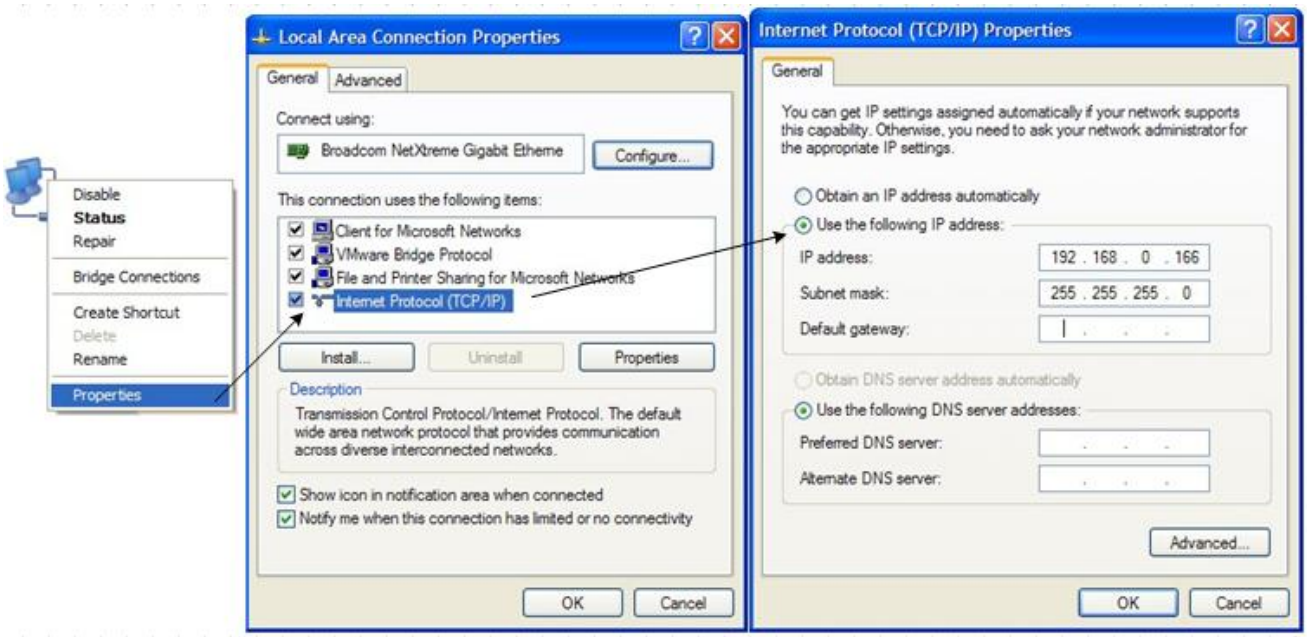


Fig.9-3 IP Configurations

9.2 LCT Monitor Settings

Ensure that network is normal, then users need to open NovaLCT-Mars, and choose advanced users, the initial pass word is "**admin**", as shown in fig.9-4

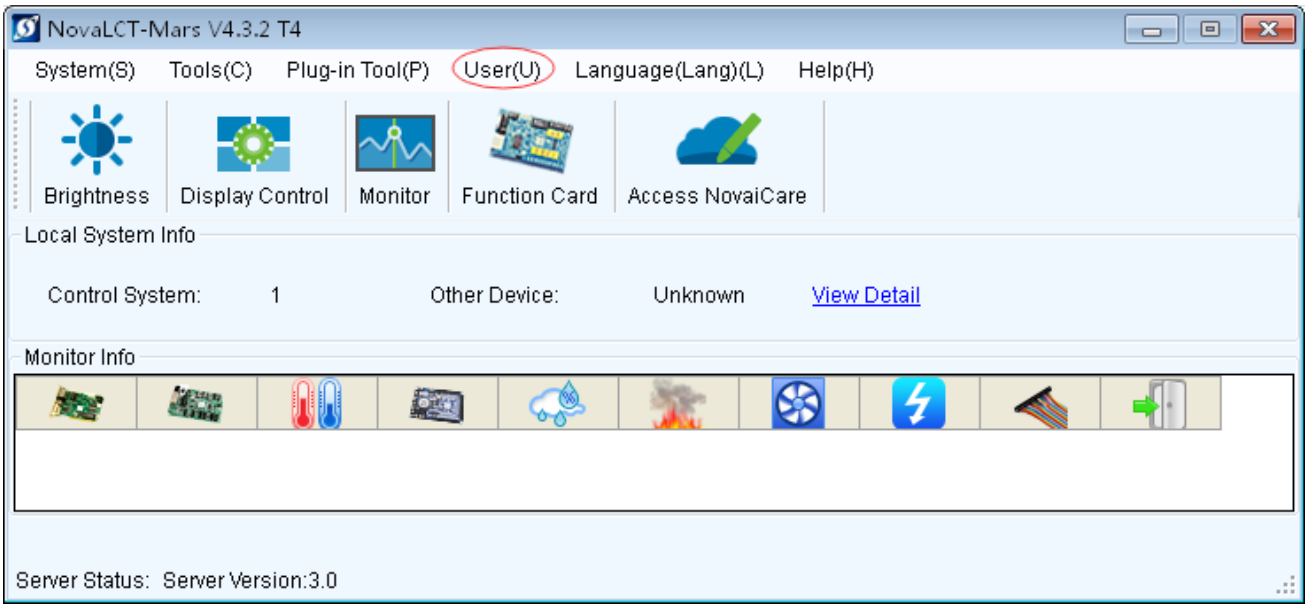


Fig.9-4 LCT Main Interface

After loading by advanced user, NovaLCT-Mars toolbar will appear calibration options, click into the calibration page.

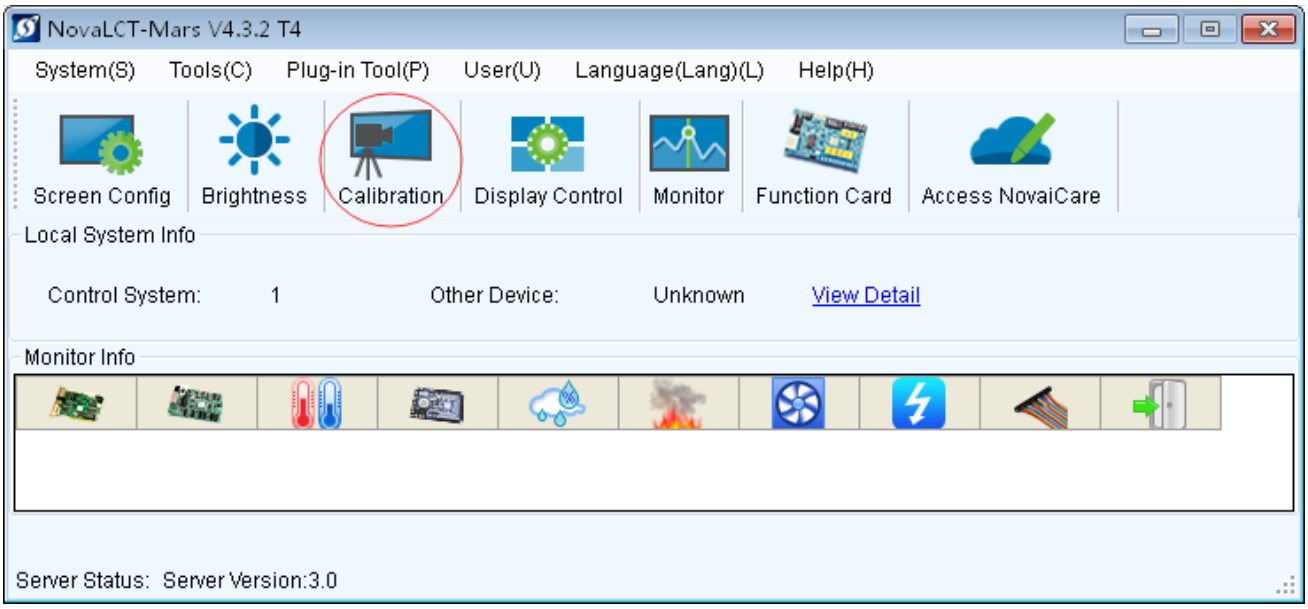


Fig.9-5 Calibration Page

After getting into the calibration page, please check the network settings to make sure network

normal, then click "Reconnect". The message of "Listening succeed" shown in the following message window indicates that calibration service has been activated, if not, please check the network.

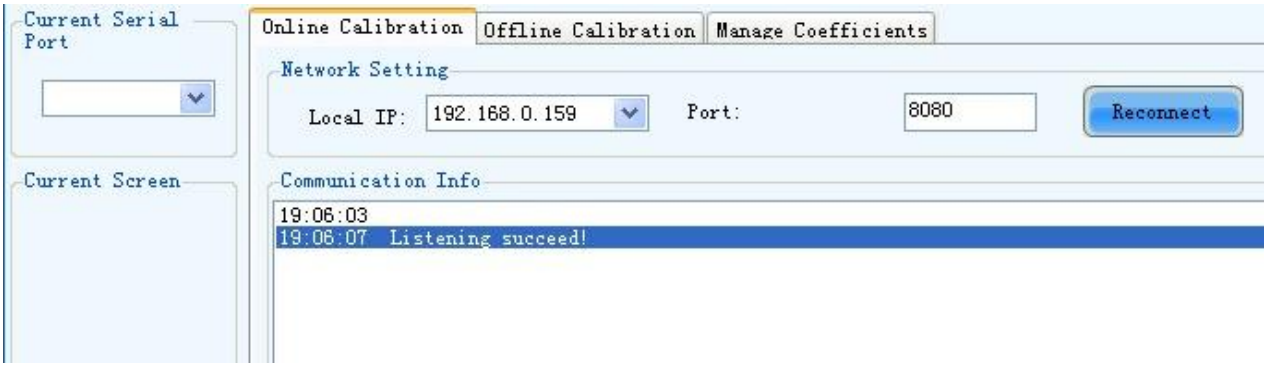


Fig.9-6 Enter into Calibration Mode

9.3 Principle of Brightness and Color Calibration

Generally speaking, it is recommended that users select brightness and color calibration mode, they can obtain higher uniformity. For some customers demanding more colorful and brighter, they can choose brightness calibration only.

- **Brightness calibration:** Brightness calibration is to adjust the brightness of LED lights to improve the brightness uniformity. In the brightness calibration, brightness of most lights will be properly lowered. Fig.9-7 shows an example of brightness adjustment of green LED lights, in which there are two brightness distribution curves corresponding to before and after calibration (adjustment) respectively. Before calibration, the brightness values of green LED lights are scattered between 2400 – 3300 cd/m^2, but after calibration those are concentrated almost at2500 cd/m^2, representing high brightness uniformity.

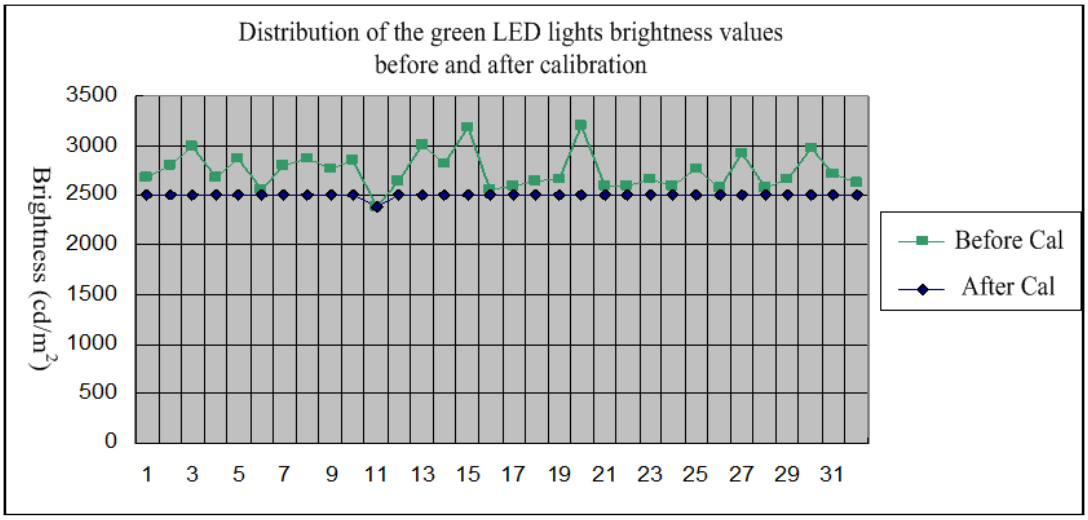


Fig.9-7 Brightness Values Distribution Before and After Calibration

✧ **Brightness and color calibration:** Brightness and color calibration is based on the theory of RGB color match. It adjusts the coordinates of LED lights in the RGB color coordinate system to reduce the color diversity. As shown in Fig.9-8, the large triangle is the gamut of a LED display before calibration , while the small one is the gamut of same LED display after calibration. The R, G and B color coordinates of LED lights scatter in relative large areas when before corrected while those after calibration are concentrated, which represents high color uniformity.

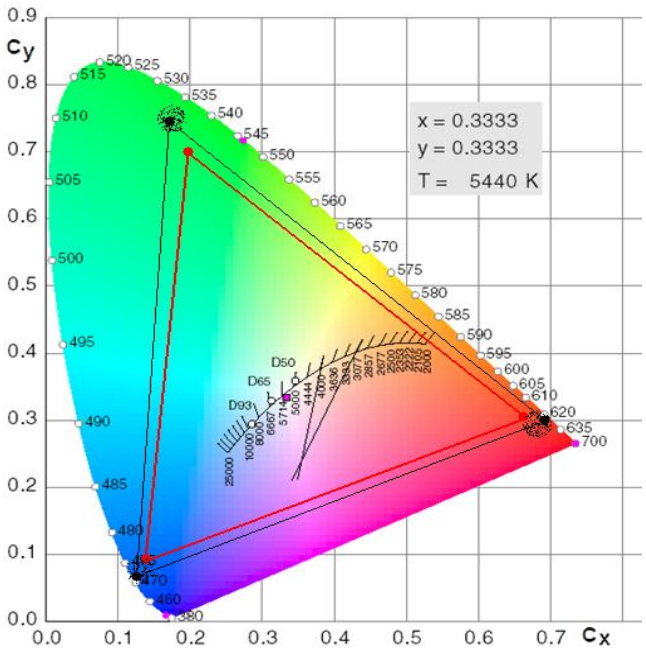


Fig.9-8 Gamut of A LED Display Before and After Calibration

Note that when performing the brightness and color calibration, proper coordinates for R, G and B should be chosen in order to avoid color distortion.

9.4 Camera Operating Skills

- Camera Preparation:

  A. Use a USB cable to connect the camera to the computer. Set the camera to "ON." Click "Connect to camera." After "Connected" is displayed, users can automatically control the camera using the software.

  B. Set the mode dial  to "M" (manually) and lens focus  to "M" (manually). If the lens supports the anti-shake function ("OS" on Sigma cameras), set  to "OFF."

  C. Switchover between eyepiece framing and LCD framing: Enable "Live view shoot" in "MENU" of the camera and press  to switch between eyepiece framing and LCD framing.

Tip: When LCD framing is enabled, users can press  **to switch among original size, five times the original size and ten times the original size for images.** 

- **Adjustment of the Camera Saturation:**

  Click "Analyze." The software automatically calculates the saturation. Adjust the aperture size, time of exposure and calibration brightness value to enable the saturation to be normal. The saturation value ranging from 30 to 100 is normal. The adjustment principle is as follows: the

adjustment must be conducted in the following order: aperture size > time of exposure > calibration brightness value. Generally, the aperture value is inversely proportional to the saturation, and the time of exposure and brightness are directly proportional to the saturation. After the red (R) saturation, green (G) saturation and blue (B) saturation are normal, click "Confirm configuration."

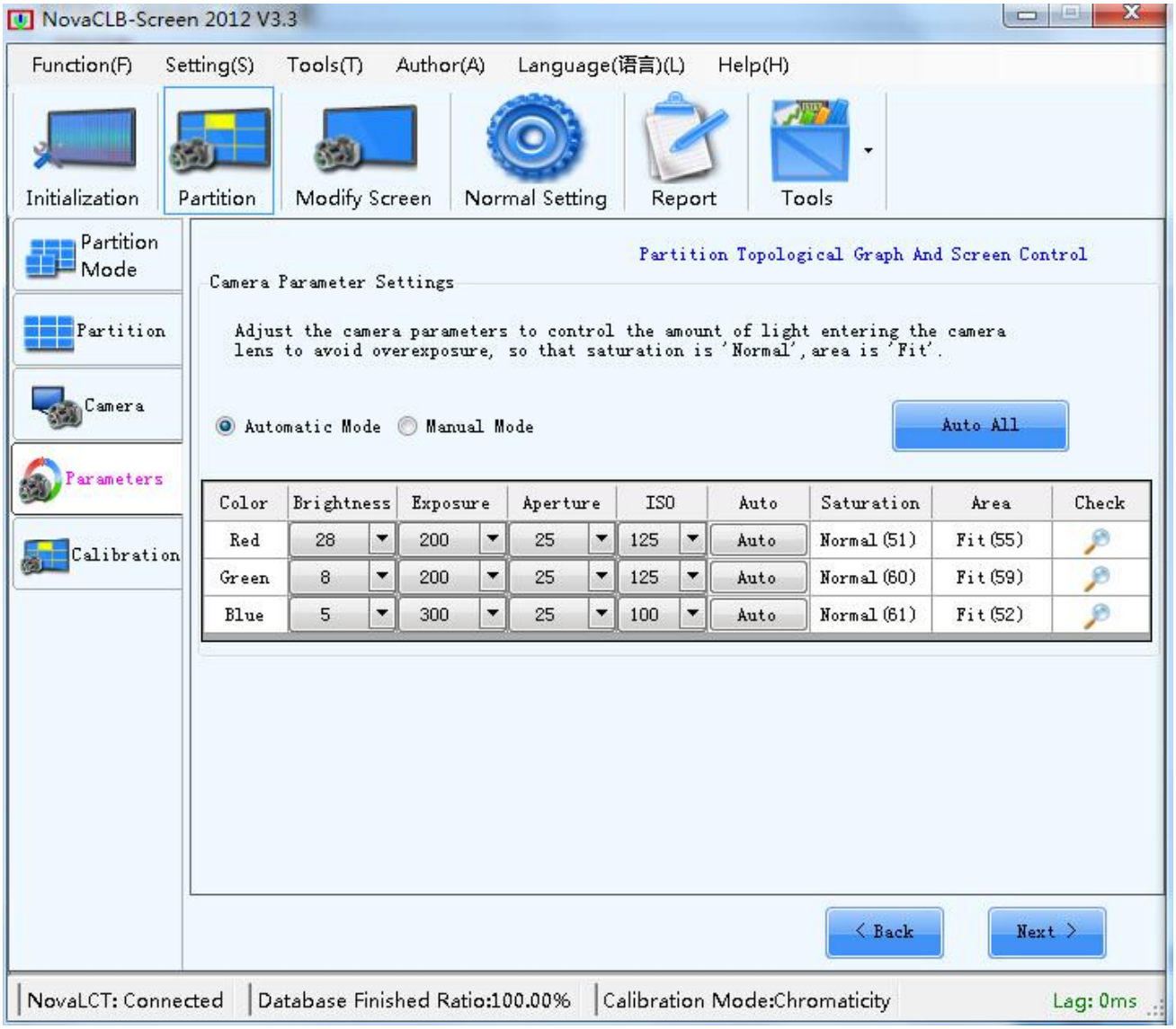


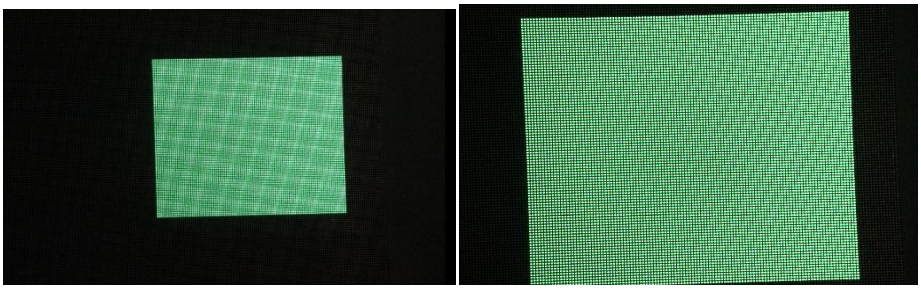
Fig.9-9 Camera Parameters Adjustment

9.5 Subarea Imaging Operating Skills

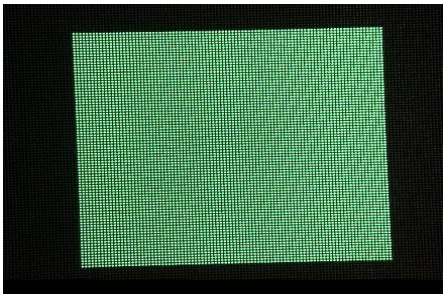
Manage the camera aim at the subarea to be calibrated and adjust lens focus length, so that the

image of the subarea has a proper view.

Because of the outer part of the lens decreases in imaging quality, the direction of the camera should be adjusted to ensure the subarea image is at the center part of the whole image. And the size of the subarea image should be about 4/5 of the whole image size. That is to leave 1/10 of the whole image at sides, as shown in Fig 9-10.



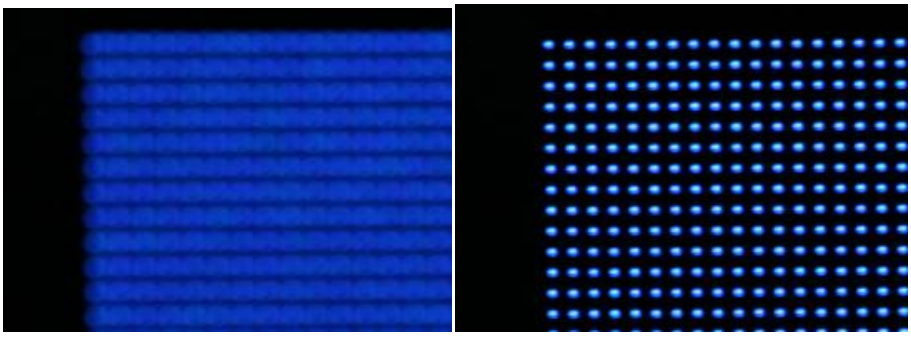
(a) Subarea Image Too Small (b) Subarea Image Too Large



(c) Suitable Subarea Image Size

Fig.9-10 Imaging of A Subarea

Adjust focus length for clear image, as shown in Fig 9-11



(a) Blur Image (b) Clear Image

Fig.9-11 Focus for Clear Image

For factory calibration, it is not recommended to use the maximum lens focus length . Because the pixel size is less than the supported maximum subarea size, the suitable focus length is that makes the cabinet view centre is at the center of the whole view.

9.6 Large partition operating technique

When selecting large partition calibration, the camera can calibrate maximum partition of 960X640 at one time, while the single partition pixel is the partition calibrated at one time with the camera, so that it is better to set the single partition pixel to be less than 960X640.

The partition photographed at one time with the camera is equivalent to the value of columns of single partition pixel dividing unit columns multiplying the value of rows of single partition pixel dividing unit rows, due to camera limitation, the unit number and single partition pixel set shall better satisfy the following conditions:

- The value of columns of single partition pixel dividing unit columns shall be less than 192;
- The value of rows of single partition pixel dividing unit rows shall be less than 128;

9.7 Steps to Check Calibration Effects

It may occur unsatisfactory calibration effects in some areas of screen after calibration, then troubleshoot according to calibration effect is needed. Before checking, users should know how to check "Camera Image Collection".

Click magnifying glass icon  in Partition calibration page, then measurement image page appears. First, observe the image resolution and integrity, second, observe whether all led points have been selected. As shown in Fig.9-12:

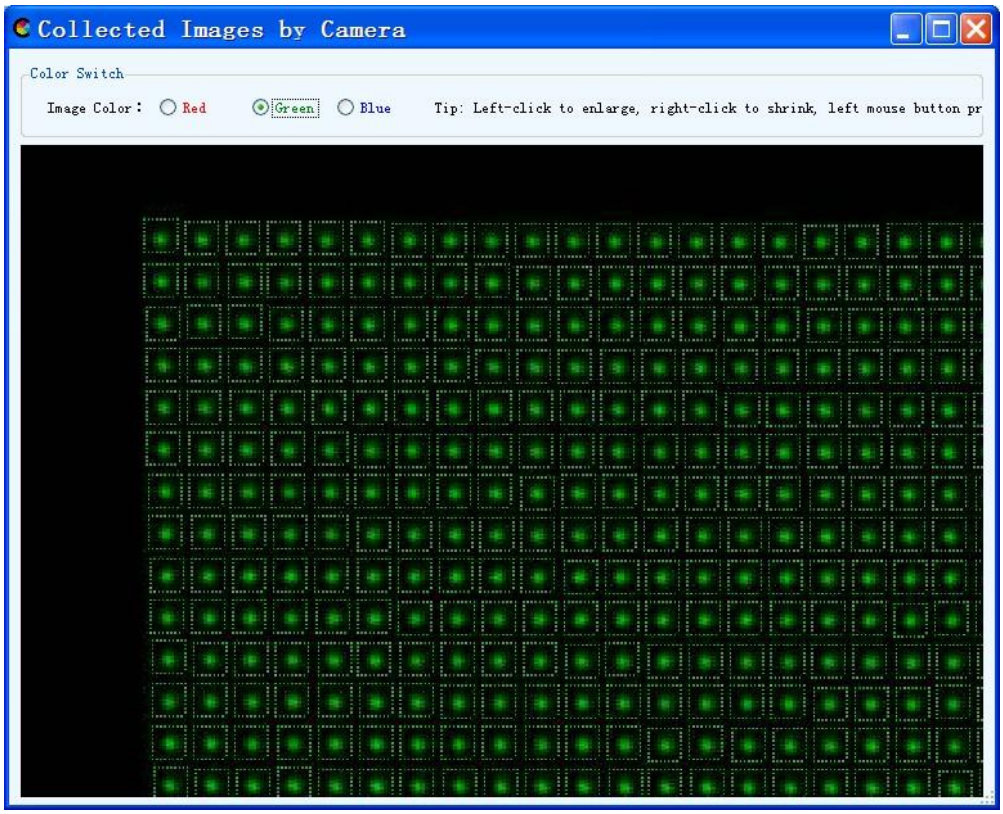


Fig.9-12 View of Collection Images

✧ **Screen fuzzy phenomenon1: there appears some bright or dark wirings in vertical direction between subareas.**

Analysis: Generally speaking, it is because of poor quality of imaging, users may check whether LED image clear or not on "Camera Image Collection". Generally both Oversize resolution when partition setting and not clear focus when the imaging may lead poor quality of imaging.

✧ **Screen fuzzy phenomenon2: there appears water ripples in subareas**

Analysis: Generally speaking, it is because of inadequate sampling. Show red, green and blue image on LED screen after calibration to find out undesirables color. Slightly adjust the focus or re-focus, then repeat the calibration of the color, you can solve the problem.

Moreover, some scene reasons may also lead unsatisfactory, for example, outside light interference, lens jitter by site windy and imaging fuzzy by rain and snow. In order to reach the most ideal effect, engineers need to avoid these influences of external environment.

9.8 Water Ripple in Full-Screen Calibration

Full-screen calibration may appear full screen of a color rendering water ripple, blue share the highest frequency. This is due to that the display resolution is too large, and the relative lack of camera resolution leads the low sampling frequency. It is known as moiré patterns phenomenon in optical imaging.

Try below resolutions to solve this problem, and then collect R/G/B again.

1) Change camera angle. Rotate camera lightly to change its angle to eliminate or reduce the existing moiré patterns.
2) Change camera position. Move camera up or down or left or right to reduce moiré patterns.
3) Change camera focusing. Too clear focus and details may cause moiré patterns, please adjust camera aperture to reduce camera focus Clarity, furthermore to reduce moiré patterns.
4) Change camera lens. Try different focus length to reduce or eliminate moiré patterns.
5) Try to divide the full screen into several parts to perform calibration when performing full screen correction. The reduction of imaging points can help eliminate Moiré Effect.

10 Edition Statement

Edition	Issuing Date	Corresponded Software Version
User Manual of NovaCLB-Screen Full Screen System-V1.0	25/09/2012	First Release
User Manual of NovaCLB-Screen Full Screen System -V2.0	19/12/2012	NovaCLB-ScreenV1.9.0
User Manual of NovaCLB-Screen Full Screen System -V2.2	06/09/2013	NovaCLB-ScreenV2.0.0
User Manual of NovaCLB-Screen Full Screen System -V3.1.0	07/03/2014	NovaCLB-ScreenV3.1.0
User Manual of NovaCLB-Screen Full Screen System -V3.2.0	08/04/2014	NovaCLB-ScreenV3.2.0
User Manual of NovaCLB-Screen Full Screen System -V3.3.1	01/26/2015	NovaCLB-ScreenV3.3.1